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ABSTRACT

This handbook offers a practical approach for pupil transportation energy management by suggesting ideas to save fuel in the purchasing, planning, routing, scheduling, driving, and maintenance areas of the pupil transportation operation. The handbook is divided into seven parts. Part 1 and 2 provide insight into energy management in pupil transportation. Part 3 discusses the driving environment variables that influence fuel economy and provides a framework for practical recommendations. Part 4 presents step-by-step guidelines for reducing fuel use in the school district. Actions that can be taken to increase fuel economy in each area of the pupil transportation operation are discussed in Part 5. Part 6 offers helpful suggestions to implement fuel economy management. This is followed by a listing of additional tips to save energy and a conclusion in Part 7. Sources that can be called on for further information and assistance and a bibliography are included in Part 8.

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ED165317

ENCOURAGING SCHOOL TRANSPORTATION EFFECTIVE ENERGY MANAGEMENT (ESTEEM)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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OCTOBER, 1977

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FOR

U. S. DEPARTMENT OF TRANSPORTATION
OFFICE OF THE SECRETARY
VOLUNTARY TRUCK AND BUS FUEL ECONOMY PROGRAM
WASHINGTON, D.C. 20590

EA 011 235

ESTEEM
ENCOURAGING SCHOOL TRANSPORTATION EFFECTIVE ENERGY MANAGEMENT

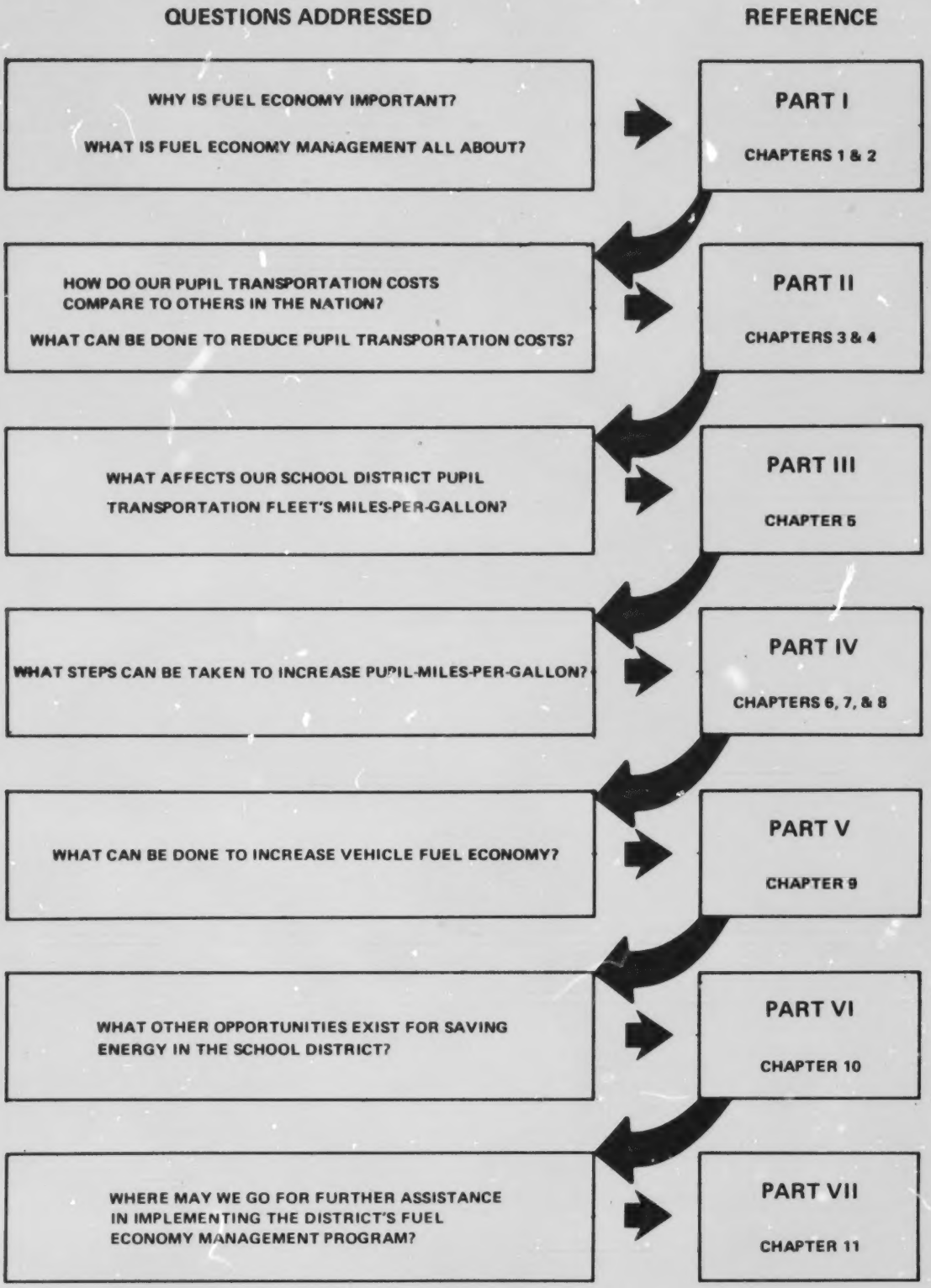
FUEL ECONOMY MANAGEMENT HANDBOOK FOR

- Directors Of Pupil Transportation
- School District Administrators
- Transportation Department Management

A summary of programs, actions, and measures designed to save fuel and dollars in pupil transportation. The contents of this handbook reflect the views of BRI Systems which is entirely responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policy of the Department of Transportation. This publication does not constitute a standard, specification or regulation.

Additional copies of this handbook are available from:
Voluntary Truck and Bus Fuel Economy Program
U. S. Department of Energy
Washington, D.C. 20461

HANDBOOK DESIGN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WHAT CAN BE DONE TO REDUCE PUPIL TRANSPORTATION COSTS?
PART II
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PART III
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RE-EXAMINE YOUR DISTRICT'S TRANSPORTATION NEEDS.
MAKE ENERGY MANAGEMENT A PART OF YOUR PROGRAM!

PREFACE

This "Encouraging School Transportation Effective Energy Management (ESTEEM)" handbook offers a practical approach for pupil transportation energy management. It has been designed to help school districts save fuel in pupil transportation, thereby increasing the esteem in which the school district's transportation service is held by the community.

The fuel economy of a school bus is determined by the energy that must be provided by its engine and the efficiency with which this energy is provided. ESTEEM addresses the areas of pupil transportation where energy can be saved and efficiency increased. The recommendations offered are based upon fuel conservation practices that have demonstrated energy savings while maintaining optimum servicing. Fuel conservation practices include implementing good management practices to eliminate waste--fuel waste, energy waste, and dollar waste. Fuel economy management is based upon a combination of simple, but effective management programs to improve pupil transportation using proven economic, behavioral science, and technological tools.

The ESTEEM handbook provides detailed information about fuel saving strategies and offers step-by-step guidance for taking actions. It is designed to be used with the U.S. Department of Transportation's publication series entitled "Fuel Economy Through Teamwork" available from the Department of Transportation, Voluntary Truck and Bus Fuel Economy Program, Washington, D. C., 20590.

PREFACE
CONTINUED

The information presented in ESTEEM is based upon energy saving programs implemented by school districts, government and industry research efforts in fuel economy, the successful experiences of commercial trucking fleets to save fuel, and fuel saving practices that have been implemented by school districts and commercial fleets to reduce waste.

Many school transportation operations have saved very large amounts of fuel and dollars by taking actions to improve fuel economy. Reductions in school bus maintenance and fuel costs of 40-60 percent or greater were successfully achieved at operations in Willoughby-East Lake City, Ohio, Paradise Valley, Arizona, and a number of districts in the States of California and Washington. The New Paltz Central School District, New York has been able to reduce its transportation budget by 34 percent in two years during a period of increasing costs for supplies and labor.

Commercial fleets such as Ryder Trucklines have been able to reduce their fuel per mile consumption by 21 percent. Fuel economy programs at the W.R. Grace Company have demonstrated miles-per-gallon increases ranging from 5 percent to over 20 percent. Eastern Express, Inc., McDonnell Douglas, Gateway Transportation, and Consolidated Freightways are among others that have increased the miles-per-gallon squeezed out of each tank of fuel.

ESTEEM is designed to assist you in re-examining your pupil transportation program to bring it up to date to meet today's needs. The number of extra miles that can be obtained from each gallon of fuel is dependent upon how serious your school district is in improving its energy posture.

ACKNOWLEDGEMENTS

Many individuals have given generously of their time, talent, and experience to assist in the preparation of this handbook. Although space prohibits mention of all those who have contributed, the Bibliography lists the principal references.

Mr. Ted Adamczyk, BRI Systems, Inc., was responsible for the handbook design and contents. He was assisted by Mr. Jerry Hard, Mrs. Sharon Klingner, and Mrs. Pamela Knorr. Appreciation is given to Ms. Wilda Levi for her efforts in designing and developing the graphic illustrations. Acknowledgement is also given to Mr. Eric Adamczyk and Mrs. Klingner for their efforts in preparing the ESTEEM handbook.

Mr. Henry Seiff, Voluntary Truck and Bus Fuel Economy Program, U.S. Department of Transportation, was instrumental in the development of this handbook. Special acknowledgement is also given to Mr. David Soule and other members of the U.S. Department of Transportation, Washington, D.C. who provided creative thought into its development.

BRI Systems expresses high appreciation to the members of the pupil transportation community who were so willing to share ideas, discuss their experiences, and review the opportunities for saving fuel so that others may benefit. This sharing of knowledge is important in saving energy.

A LISTING OF TERMS REFERENCED IN THE HANDBOOK

BRITISH THERMAL UNIT (BTU)—— THE ENERGY REQUIRED TO RAISE THE TEMPERATURE OF 1 POUND OF WATER BY 1 DEGREE FAHRENHEIT.

EFFICIENCY—— THE RATIO OF THE USEFUL POWER OUTPUT FROM A PROCESS AS COMPARED TO THE INPUT POWER SUPPLIED; THE EFFICIENCY OF AN ENGINE, FOR EXAMPLE, DEFINES THE PERCENT OF COMBUSTION HEAT WHICH ENDS UP AS MECHANICAL POWER.

ENERGY—— THE CAPACITY TO PERFORM WORK.

FOSSIL FUEL—— FUEL DERIVED FROM FOSSIL REMAINS OF ORGANIC MATERIALS; GASOLINE AND FUEL OIL ARE FOSSIL FUELS.

FUEL ECONOMY—— THE RATIO OF VEHICLE MILES DRIVEN TO THE FUEL THAT IS CONSUMED (MILES-PER-GALLONS).

HORSEPOWER—— A RATE OF PERFORMING WORK; ONE HORSEPOWER (HP) CAN MOVE A 550-POUND FORCE 1 FOOT IN 1 SECOND.

POWER—— THE RATE AT WHICH ENERGY IS GENERATED OR USED.

WORK—— EFFORT OR FORCE EXERTED THROUGH A GIVEN DISTANCE.

TECHNICAL TERMS REFERENCED IN CHAPTERS 5 AND 9

DRAG FORCES — FORCES THAT RETARD VEHICLE MOTION.

DRIVE TRAIN — THE ENGINE, TRANSMISSION, PROPELLER SHAFTS, AXLES, AND ALL OTHER PARTS ACTIVE IN TRANSMITTING POWER TO THE WHEELS.

DRIVELINE LOSSES — LOSSES IN THE TRANSMISSION, PROPELLER SHAFTS, AND DRIVE AXLES.

ENGINE GOVERNOR — AN ENGINE SPEED LIMITING DEVICE THAT BEGINS REDUCING POWER AT THE FULL THROTTLE RPM SETTING.

ENGINE LUGGING — OPERATING THE ENGINE UNDER LOAD AT AN RPM LOW ENOUGH TO CAUSE UNSTABLE FUNCTIONING.

GOVERNED RPM — FULL THROTTLE SETTING OF THE ENGINE GOVERNOR OR THE RPM AT WHICH THE GOVERNOR BEGINS TO REDUCE POWER.

GRADEABILITY — THE MAXIMUM GRADE A VEHICLE CAN CLIMB AT A CONSTANT SPEED.

GROSS HORSEPOWER — THE ENGINE HORSEPOWER AT THE FLYWHEEL WITHOUT ACCESSORIES FUNCTIONING.

NET HORSEPOWER — THE ENGINE HORSEPOWER AT THE FLYWHEEL WITH ALL ACCESSORIES RUNNING AS INSTALLED IN THE VEHICLE.

RPM (REVOLUTIONS PER MINUTE) — A MEASURE OF ENGINE SPEED.

PART I

INTRODUCTION

WHAT ENERGY MANAGEMENT AND FUEL ECONOMY ARE ALL ABOUT

THOSE WHO DO NOT REMEMBER THE PAST
ARE CONDEMNED TO RELIVE IT.

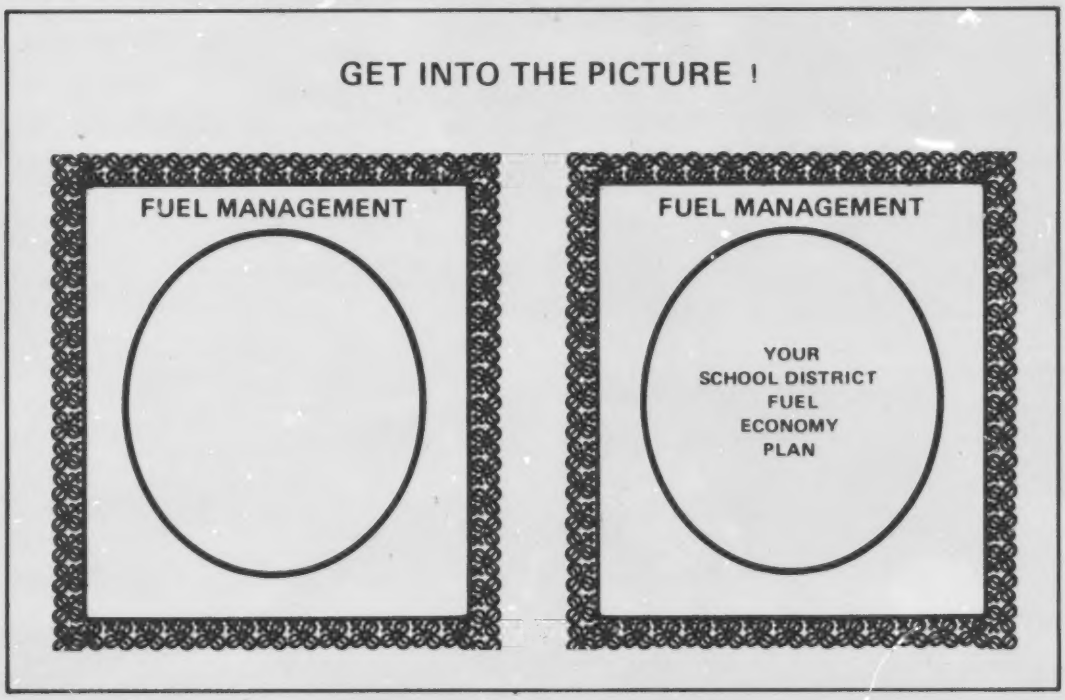
GEORGE SANTAYANA, PHILOSOPHER

1.1 ESTEEM HANDBOOK PURPOSE

Everyone talks about energy management, but little guidance has been given to help school districts combat the problems that have arisen due to spiraling fuel prices. The Voluntary Truck and Bus Fuel Economy Program, recognizing the need for energy information dissemination in the educational community, has sponsored this effort to help school districts save fuel and dollars.

The lifeblood of the school transportation fleet, fuel, has risen in cost significantly since 1973. No one knows how much more fuel prices will increase. Each school district must face many uncertainties with a very limited budget.

Fuel economy management represents an alternative for combating this crisis. The intent of this handbook is to provide an understanding of management actions that can save fuel and control pupil transportation costs. The objective is to help each school district become a part of our national fuel economy management team.



1.2 HANDBOOK DESIGN

The ESTEEM handbook is divided into seven (7) parts. In the first, an introduction to the handbook is presented. The topics discussed in the following parts include:

PART II : Reviewing the Need for a Fuel Economy Program

PART III: Understanding What Contributes to Fuel Economy

PART IV : Developing Your Solution to the Energy Crisis

PART V : Guidelines for Increasing Fuel Economy

PART VI : Conclusion

PART VII: Reference Information

Part I and Part II provide insight into energy management in pupil transportation.

Part III discusses the driving environment variables that influence fuel economy. It provides a framework for practical and sound recommendations to save fuel which are offered in Part IV and Part V

Part IV presents step-by-step guidelines for reducing fuel use in the school district. Actions that can be taken to increase fuel economy in each area of the pupil transportation operation are discussed in Part V.

Part VI offers helpful suggestions to implement fuel economy management. This is followed by a listing of additional tips to save energy.

Sources that can be called upon for further information and assistance are identified in Part VII. A bibliography of references is also included in Part VII.

A SUMMARY OF ACTIONS THAT SAVE FUEL AND OPERATING COSTS IN PUPIL TRANSPORTATION

1.3 USING THE HANDBOOK

ESTEEM offers insight into what can be done to save fuel. Each school district must translate the recommendations offered into an action plan that spells out when the school district's program will be performed and what part each individual will play in it. The ultimate objective of ESTEEM is to help each school district bring its pupil transportation program up to peak energy efficiency and to maintain this efficiency through continuing management efforts.

This handbook offers guidance in taking actions that save fuel and dollars in many areas of pupil transportation. All of the fuel saving opportunities presented may not apply to every pupil transportation operation. Some recommendations offered may also be an extension of programs currently being implemented.

Every school district administrator and transportation supervisor should read Parts II, III, and IV of the handbook to obtain an understanding of what contributes to fuel economy, what can be done to increase pupil-miles-per-gallon, and to recognize why even simple actions taken to increase fuel economy are important.

Part V should be consulted for ideas to save fuel in the purchasing, planning, routing, scheduling, driving, and maintenance areas of the pupil transportation operation.

ESTEEM is designed to assist pupil transportation administrators to identify fuel saving opportunities and to evaluate actions that can increase the transportation fleet's pupil-miles-per-gallon to combat rising fuel prices.

**MAKE FUEL ECONOMY MANAGEMENT
A PART OF YOUR MANAGEMENT PROGRAM.**

2.1 ENERGY MANAGEMENT: A SYNOPSIS

There are two types of energy which affect pupil transportation. Each plays an important role in the transportation of pupils.

The first type of energy has been making headlines since the 1973 oil embargo and everyone is aware of it--fuel energy. This energy consists of the fuel and oil that are used to power a school bus. It is obtained from precious fossil fuel resources which are being used at an increasing rate.

Since the 1973 energy crisis, many school transportation administrators have initiated efforts to reduce the amount of fuel required to operate their fleets. Rapidly escalating fuel prices and limited school budgets offer a strong incentive for reducing fuel use in every school fleet.

A second type of energy is just as important--people energy--the awesome energy exhibited by administrators, directors of pupil transportation, bus drivers, maintenance personnel, and others, to commit to the making of an effective pupil transportation operation.

The energy of individuals was around long before the energy crisis; furthermore, there is a surplus of it in every school district--a surplus that can be used to implement actions to conserve fuel. This energy is important and should be harvested. Energy management consists of effective use of both types of energy.

ENERGY HEATING VALUES

1 GALLON	BTU'S	1 UNIT TRANSLATES INTO	BTU'S
GASOLINE	125,000	CUBIC FOOT NATURAL GAS	1,031
KEROSENE	134,000	HORSEPOWER-HOUR	2,545
NO. 2 FUEL OIL	140,000	KILOWATT-HOUR	3,413
NO. 4 FUEL OIL	144,000	TON OF COAL	25,000,000

2.2 ENERGY MANAGEMENT AND FUEL ECONOMY

Many differences exist in pupil transportation servicing requirements; this is seen in the variations that occur in administrative and operation policies and procedures, vehicle fleet make-up, miles driven, and fuel consumed. Viewing fuel use from a national standpoint, the average school bus is driven almost 7,000 miles each year and consumes nearly 950 gallons of fuel. It has a fuel economy of 7.4 miles-per-gallon (mpg). This is based upon gasoline and diesel models, large and small buses, and includes all vehicles used by schools in the transport of pupils. Some school buses get as little as 3 mpg; other fleets show fuel economies much higher than the national average.

SCHOOL BUS TRAVEL AND FUEL CONSUMPTION
1940–1974 PROFILE

YEAR OF RECORD	AVERAGE ANNUAL MILES TRAVELED	AVERAGE FUEL CONSUMPTION (GALLONS)	AVERAGE MILES-PER-GALLON
1974	6,867	933	7.4
1970	7,274	1,039	7.0
1960	7,556	1,066	7.1
1950	7,775	748	10.4
1940	8,011	775	10.3

Source: U.S. Department of Transportation, Federal Highway Administration, Highway Statistics, 1976.

INCREASED FUEL ECONOMY IS AN ACHIEVABLE GOAL.

Increased fuel economy has to be an important goal in every transportation operation. Efforts taken to increase your school bus fleet's fuel economy are fully in line with management's objectives to increase operation efficiency and hold costs down.

2.3 FUEL ECONOMY MANAGEMENT IN PERSPECTIVE

A fuel economy management program consists of planned actions to safely transport the maximum number of pupils using the minimum amount of fuel that is practical in doing so.

Every fuel economy management program has four (4) basic objectives:

1. Define areas of fuel use inefficiency and waste within the school district operation.
2. Make administrative and operation personnel, staff, students, and the community aware of the potential for fuel conservation in the school district.
3. Update the policies of the school district and programs of the district's transportation operation to meet self-determined energy saving goals.
4. Effect corrective actions to increase the district's pupil-miles-per-gallon.

The most important element of fuel economy management is teamwork--efforts of school administrators, the transportation department staff, teachers, students, and the community working as a single, cohesive unit to save energy.

Each Director of Pupil Transportation plays an important role in guiding the team. The Director is in a unique position to offer advice and leadership to the school district, based upon experience, which can result in fuel and dollar savings. He can guide the implementation of a program to provide more efficient pupil servicing, better utilization of school vehicles, school district dollar savings, and a reinforcement of important relationships among pupils, school personnel, and parents.

PLAN, REVIEW, AND EXECUTE PROGRAMS THAT SAVE FUEL !

2.3 FUEL ECONOMY MANAGEMENT IN PERSPECTIVE

The approach to fuel economy management considers that a series of interrelated steps lead from a problem to its solution:

Step 1. Define the Pupil transportation problems in the school district. Review the current situation and trend. Does the district's transportation program lead to "cost prevention" -- eliminating costs before they occur?

Step 2. Get the facts. Without facts, it is hard to determine whether there are problems and what can be done to solve them. Gather fuel, equipment, and labor reports, variance reports, and all other information that is available to review each problem and its potential solution.

Step 3. Digest and examine the solutions to each problem. Determine how each solution can improve service and/or reduce pupil transportation costs. Understand the alternatives that are available -- base this understanding on facts, not assumptions.

Step 4. Decide on the best solution to each problem. Evaluate each alternative. Identify its benefits and costs. Also determine any potential problems that could occur if the solution were implemented.

Step 5. Take actions. Up to this step, all savings are on paper. Sell the decision, take actions to put the decision into effect, and follow up on it.

ESTEEM offers guidance in performing these steps.

REVIEW.
EVALUATE.
ACT!

PART II

REVIEWING THE NEED FOR A FUEL ECONOMY MANAGEMENT PROGRAM

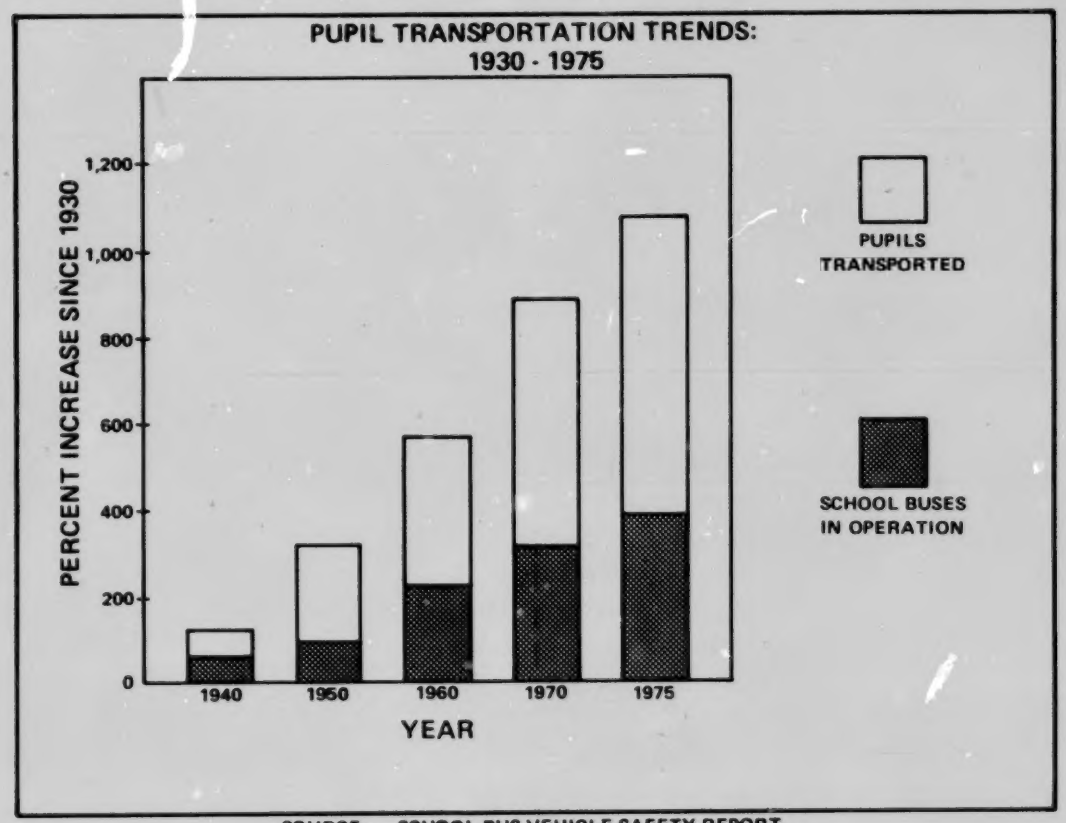
THE CHANCES OF SUCCESS OF A GIVEN INVESTMENT DEPEND ON THE EFFICIENCY WITH WHICH ALL THOSE WHO WORK IN THE SAME FIRM COOPERATE WITH THE FACTOR IN QUESTION.

J. R. HICKS, ECONOMICA, 1935

3.1 MOMENTUM OF PUPIL TRANSPORTATION GROWTH

The population increases of the past decades, the increased mobility of the American family combined with emphasis on equal educational opportunity for all, and increased school district consolidation have resulted in increasing numbers of pupils who can no longer walk to school. School buses were used to transport 51.5 percent of all students in the primary and secondary schools of our nation during the 1974-75 school year.

The National Center for Educational Statistics shows that nearly 268,000 school vehicles are used to transport 21 million pupils attending grades K through 12. The sizeable increase in the number of students requiring transportation in each decade since 1930 is shown below; this demand has placed additional burdens upon many school districts.



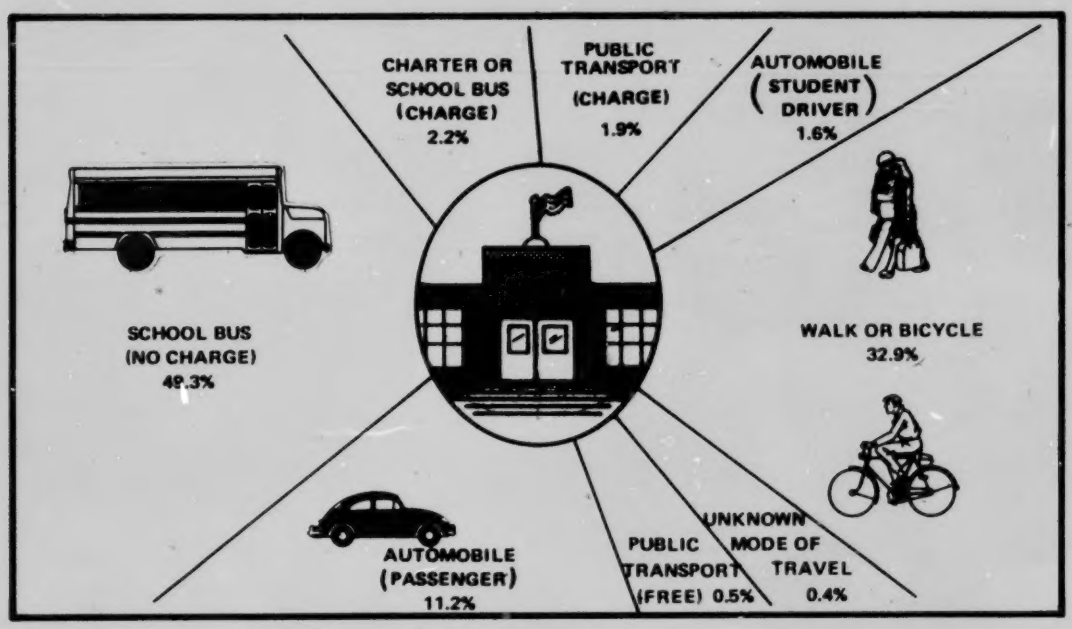
SOURCE: SCHOOL BUS VEHICLE SAFETY REPORT, U. S. DEPARTMENT OF TRANSPORTATION, WASHINGTON, D. C., 1977.

3.1 MOMENTUM OF PUPIL TRANSPORTATION GROWTH

During the 1974-75 school year, 63 percent of all students transported had to be driven distances of over 3 miles to attend school. The average pupil trip distances are shown on the following page. As seen below, school buses were used to transport the greatest percentage of all students between their home and school.

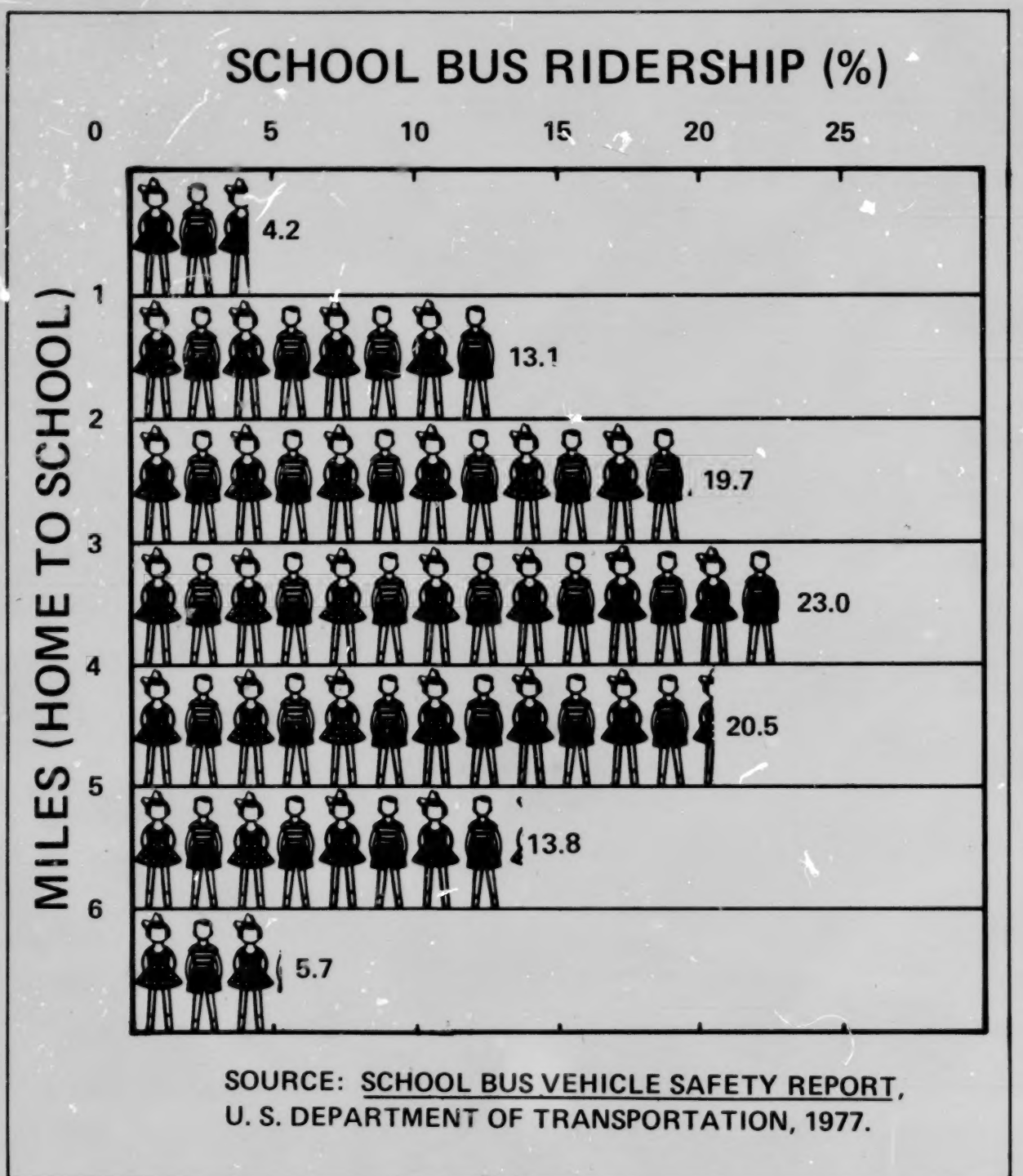
Over two-thirds of all students made the one-way trip from their home to school in less than 20 minutes. As students progress from elementary to senior grade levels, the distance and travel time from home-to-school increases. Nearly 25 percent of all elementary grade students live distances of 3 miles or greater from their schools of attendance. Forty-seven (47) percent of all senior grade level students must travel 3 miles or more to attend school.

STUDENT MODES OF TRANSPORTATION: 1974


CHARTER OR SCHOOL BUS (CHARGE) 2.2%
PUBLIC TRANSPORT (CHARGE) 1.9%
AUTOMOBILE (STUDENT DRIVER) 1.6%
SCHOOL BUS (NO CHARGE) 49.3%
WALK OR BICYCLE 32.9%
AUTOMOBILE (PASSENGER) 11.2%
PUBLIC TRANSPORT (FREE) 0.5%
UNKNOWN MODE OF TRAVEL 0.4%

SOURCES: NATIONWIDE PERSONAL TRANSPORTATION STUDY, TRANSPORTATION CHARACTERISTICS OF SCHOOL CHILDREN, JULY, 1972; U. S. NATIONAL CENTER FOR EDUCATIONAL STATISTICS, STATISTICS OF STATE SCHOOL SYSTEMS, 1976.

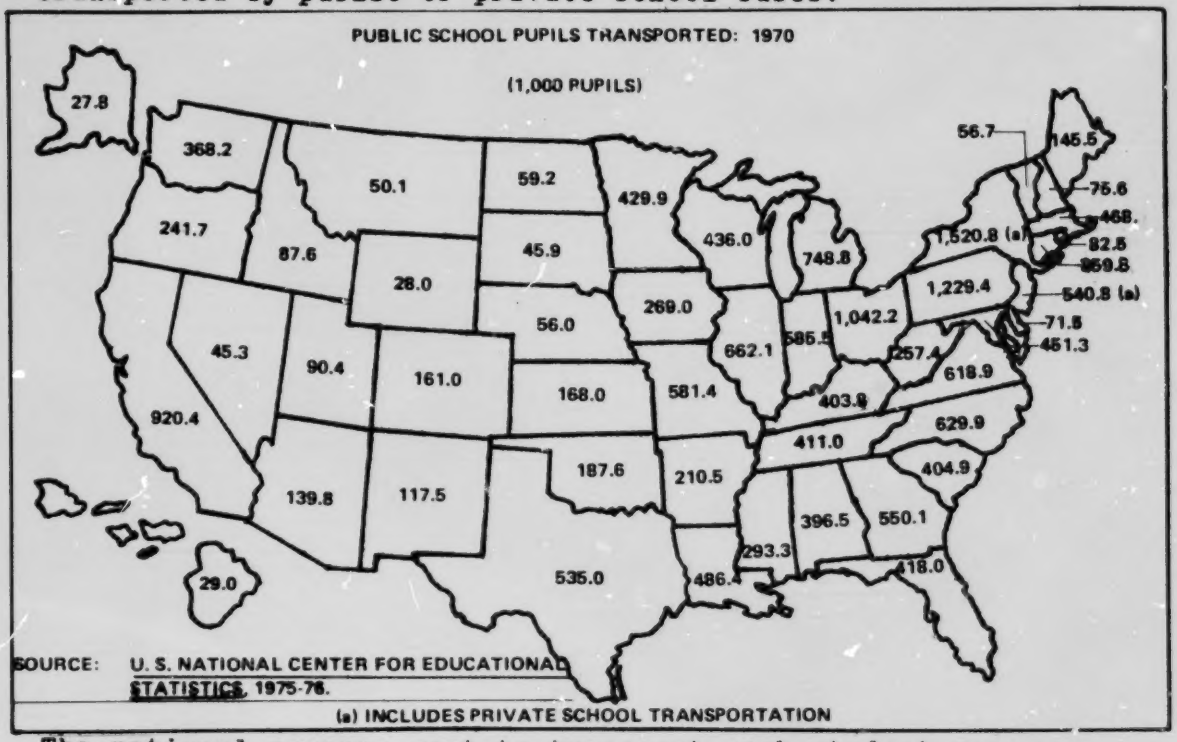
PUPIL TRAVEL DISTANCE



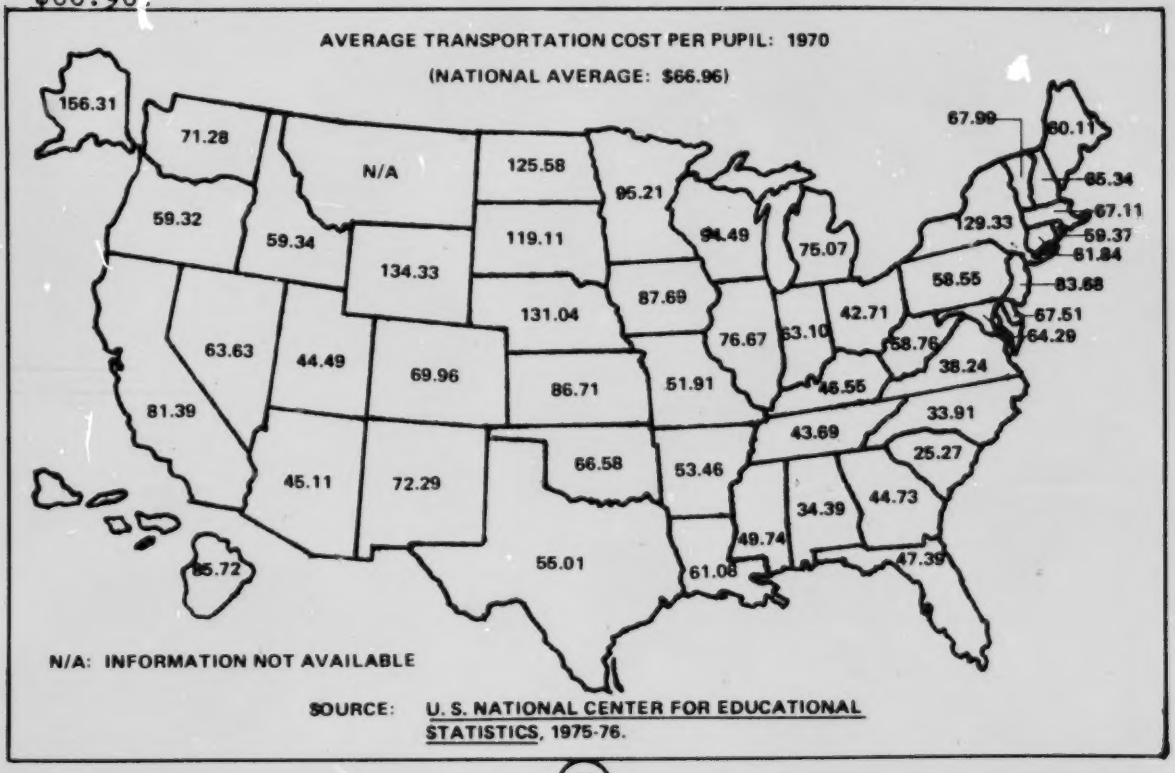
SOURCE: SCHOOL BUS VEHICLE SAFETY REPORT,
U. S. DEPARTMENT OF TRANSPORTATION, 1977.

PUPIL TRANSPORTATION IN 1970

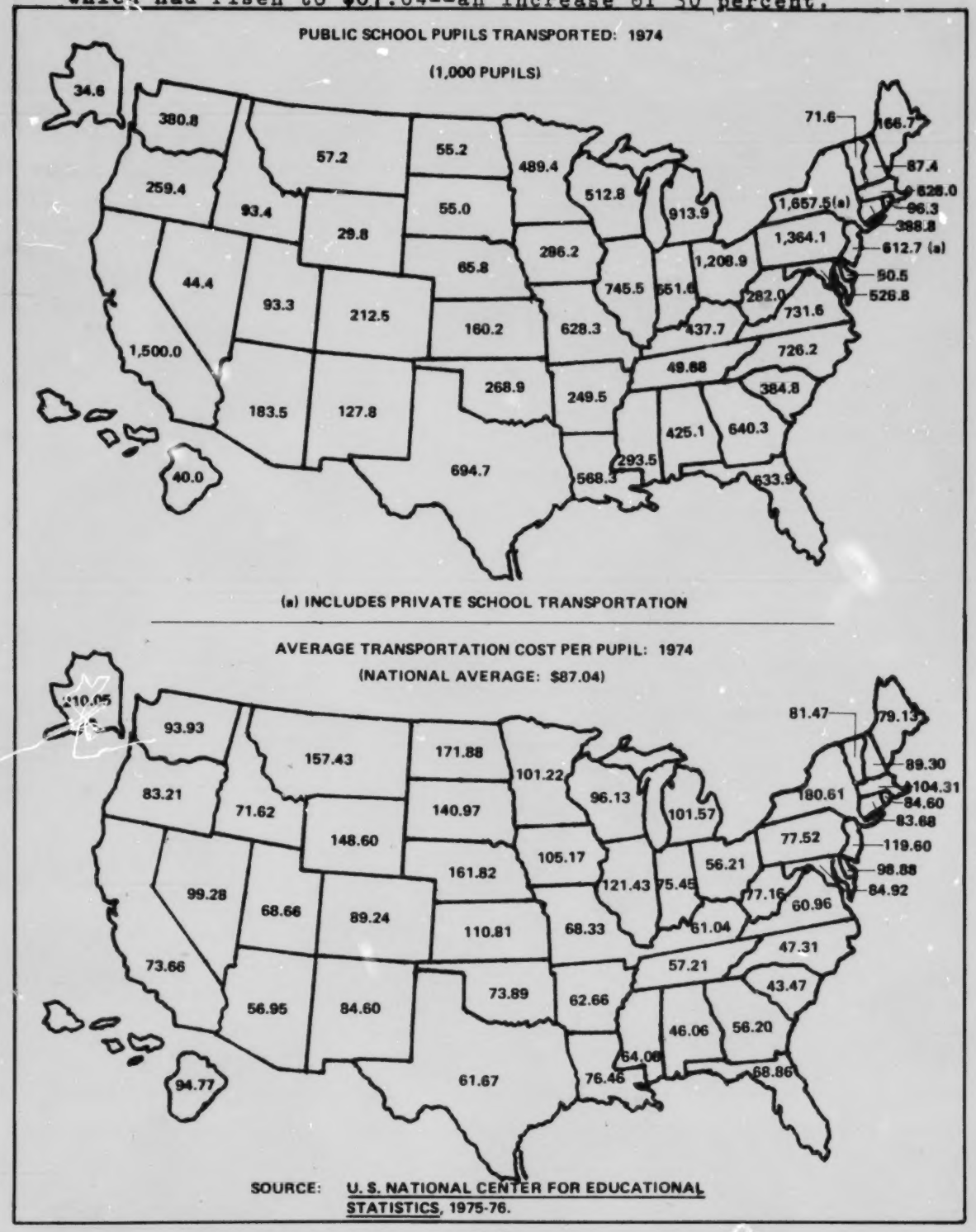
In 1970, 43.4 percent of all pupils in the nation were transported by public or private school buses.



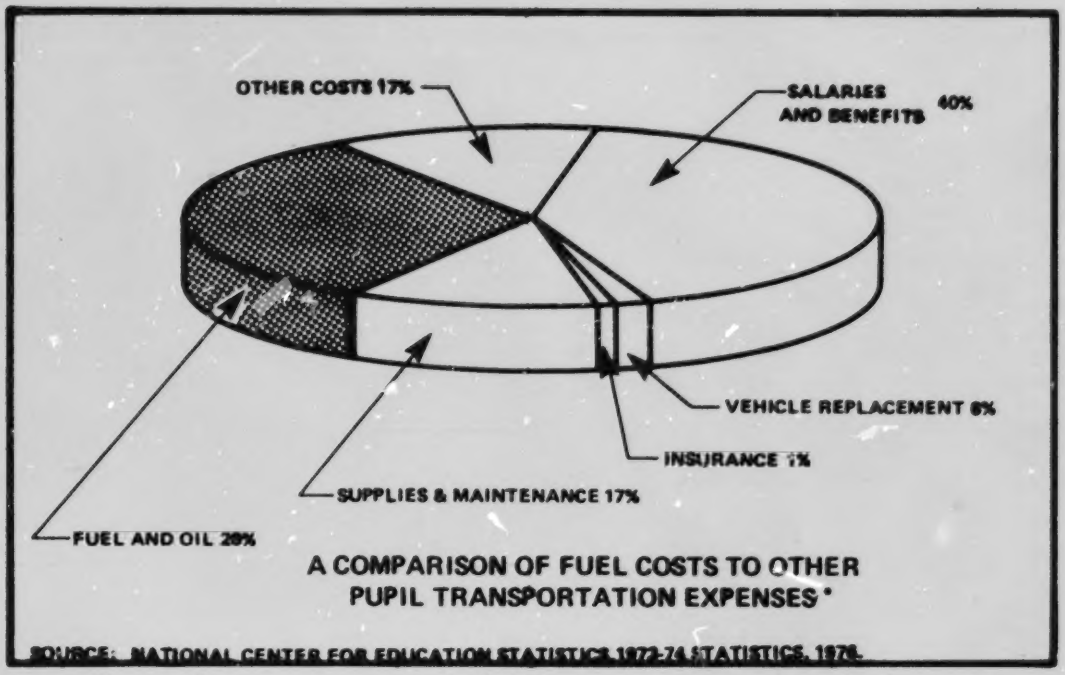
The national average cost to transport each student was $66.96.



Four short years later, 51.5 percent of all the nation's students had to be transported at an average cost which had risen to $87.04--an increase of 30 percent.



3.2 TRENDS IN PUPIL TRANSPORTATION COSTS



A COMPARISON OF FUEL COSTS TO OTHER PUPIL TRANSPORTATION EXPENSES*

SOURCE: NATIONAL CENTER FOR EDUCATION STATISTICS 1973-74 STATISTICS, 1976.

In 1974 the national average cost per school bus mile driven in the U.S. was 72¢. The average cost varied between $0.41 and $1.63 per school bus mile in individual states.

Salaries and benefits represented a major portion of this cost in many states as seen in the table on the following page. On the average, salaries and benefits account for 40 percent of pupil servicing costs; although in some states this cost represented only 5-6 percent of the total pupil transportation expenditure--again indicating the wide variations that exist in pupil transportation servicing.

The cost of fuel and oil in school bus operation also accounts for a significant portion of the total transportation expenditure. The average distribution of pupil transportation costs during the 1974 school year is shown above.

---

* COST DATA FROM STATES OF ARIZONA, CALIFORNIA, FLORIDA, MISSOURI, PENNSYLVANIA, AND WASHINGTON USED AS A BASIS TO SEPARATE FUEL, OIL, SUPPLIES, AND MAINTENANCE COSTS FROM NATIONAL STATISTICAL DATA.

3.2 TRENDS IN PUPIL TRANSPORTATION COSTS

TRANSPORTATION EXPENDITURES
PUBLIC SCHOOLS: 1974

STATE	TRANSPORTATION COST AS A PERCENT OF TOTAL EDUCATIONAL EXPENDITURES	TRANSPORTATION ELEMENT COST EXPRESSED AS A PERCENT OF TOTAL PUPIL TRANSPORTATION DOLLARS		
		SALARIES AND BENEFITS	VEHICLE REPLACEMENT	FUEL & SUPPLIES (a)
U.S. Average	3.7	40.0	6.0	54.0
Alabama	3.2	N/A	N/A	N/A
Alaska	4.6	N/A	N/A	N/A
Arizona	2.3	60.6	N/A	N/A
Arkansas	4.7	43.0	13.9	43.1
California	2.0	52.8	N/A	N/A
Colorado	3.2	53.3	14.6	32.1
Connecticut	3.9	5.4	0.9	93.7
Delaware	4.7	9.4	2.3	88.3
Florida	3.0	58.8	8.0	33.2
Georgia	4.2	55.5	15.5	29.0
Hawaii	1.8	N/A	N/A	N/A
Idaho	4.4	39.0	2.0	59.0
Illinois	3.3	26.4	5.8	67.8
Indiana	4.5	34.0	6.7	59.3
Iowa	4.5	N/A	N/A	N/A
Kansas	3.7	34.4	9.3	56.3
Kentucky	5.1	46.1	14.7	39.2
Louisiana	5.8	85.8	3.7	10.5
Maine	5.9	31.3	13.2	55.5
Maryland	4.2	32.1	2.9	65.0
Massachusetts	4.2	6.8	0.4	92.8
Michigan	3.4	52.2	15.0	32.8
Minnesota	5.2	26.9	8.4	64.7
Mississippi	5.0	47.8	15.8	36.4
Missouri	4.7	32.9	9.9	57.2

(a) INCLUDES FUEL, MAINTENANCE, INSURANCE, FARES, CONTRACT SERVICES, AND PAYMENTS.

N/A: INFORMATION NOT AVAILABLE

SOURCE: NATIONAL CENTER FOR EDUCATIONAL STATISTICS, DEPARTMENT OF HEALTH, EDUCATION AND WELFARE, 1976.

SAVING IS NOT
SPENDING SO MUCH !

3.2 TRENDS IN PUPIL TRANSPORTATION COSTS

TRANSPORTATION EXPENDITURES
PUBLIC SCHOOLS: 1974

STATE	TRANSPORTATION COST AS A PERCENT OF TOTAL EDUCATIONAL EXPENDITURES	TRANSPORTATION ELEMENT COST EXPRESSED AS A PERCENT OF TOTAL PUPIL TRANSPORTATION DOLLARS		
		SALARIES AND BENEFITS	VEHICLE REPLACEMENT	FUEL & SUPPLIES (a)
Montana	4.8	N/A	N/A	N/A
Nebraska	3.1	39.0	21.0	40.0
Nevada	3.3	62.6	8.6	28.8
New Hampshire	4.9	8.8	1.7	89.5
New Jersey	3.5	26.5	5.4	68.1
New Mexico	4.4	4.9	1.9	93.2
New York	4.8	22.7	2.3	75.0
North Carolina	3.3	54.7	19.2	26.1
North Dakota	7.1	27.1	14.0	58.9
Ohio	2.9	64.0	N/A	N/A
Oklahoma	4.0	40.0	21.0	39.0
Oregon	3.7	38.6	10.3	51.1
Pennsylvania	3.7	19.8	2.8	77.4
Rhode Island	3.7	18.9	N/A	N/A
South Carolina	3.3	52.8	19.7	27.5
South Dakota	5.3	25.1	6.7	68.2
Tennessee	4.1	41.3	4.6	54.1
Texas	1.9	55.1	N/A	N/A
Utah	2.6	53.8	10.1	36.1
Vermont	4.9	25.2	8.1	66.7
Virginia	4.2	52.0	14.4	33.6
Washington	4.0	56.2	6.8	37.0
Washington, D.C.	3.3	26.5	1.6	71.9
West Virginia	6.4	64.3	11.4	24.3
Wisconsin	4.5	12.4	4.7	82.9
Wyoming	4.4	39.8	N/A	N/A

(a) INCLUDES FUEL, MAINTENANCE, INSURANCE, FARES, CONTRACT SERVICES, AND PAYMENTS.

N/A: INFORMATION NOT AVAILABLE

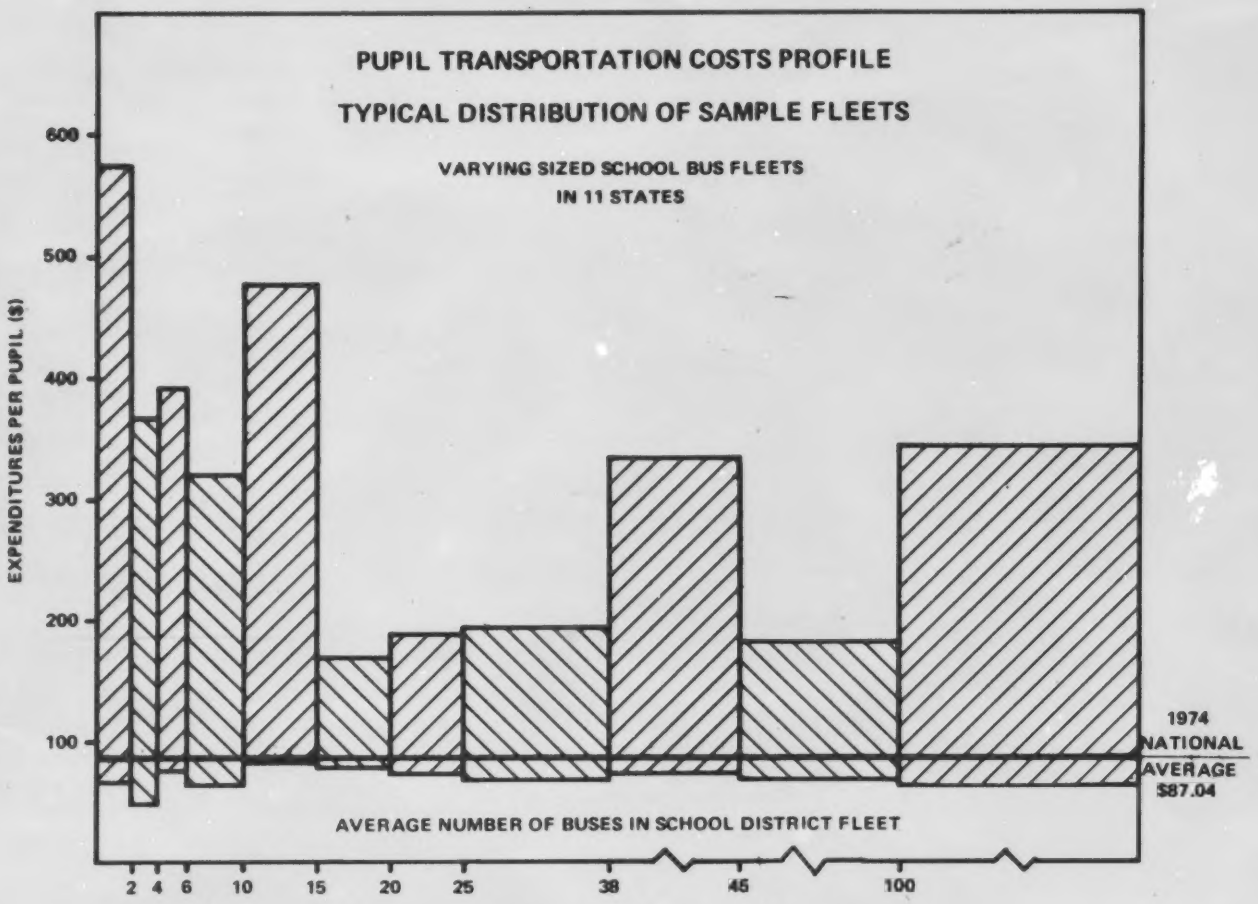
SOURCE: NATIONAL CENTER FOR EDUCATIONAL STATISTICS, DEPARTMENT OF HEALTH, EDUCATION AND WELFARE, 1976.

PURCHASE WISELY.
PURCHASE FOR FUEL ECONOMY!

3.2 TRENDS IN PUPIL TRANSPORTATION COSTS

A wide variation exists in the costs to transport pupils. The average state pupil transportation cost varied between $43.47 and $210.05 per pupil during 1974.

A typical distribution of pupil transportation costs for school bus fleets of varying size is shown below. The costs in each fleet are dependent upon many factors--maintenance programs, vehicle utilization, scheduling, routing, and driver skills--in operations that must service communities having many differences in the characteristics that influence the overall cost of transportation.



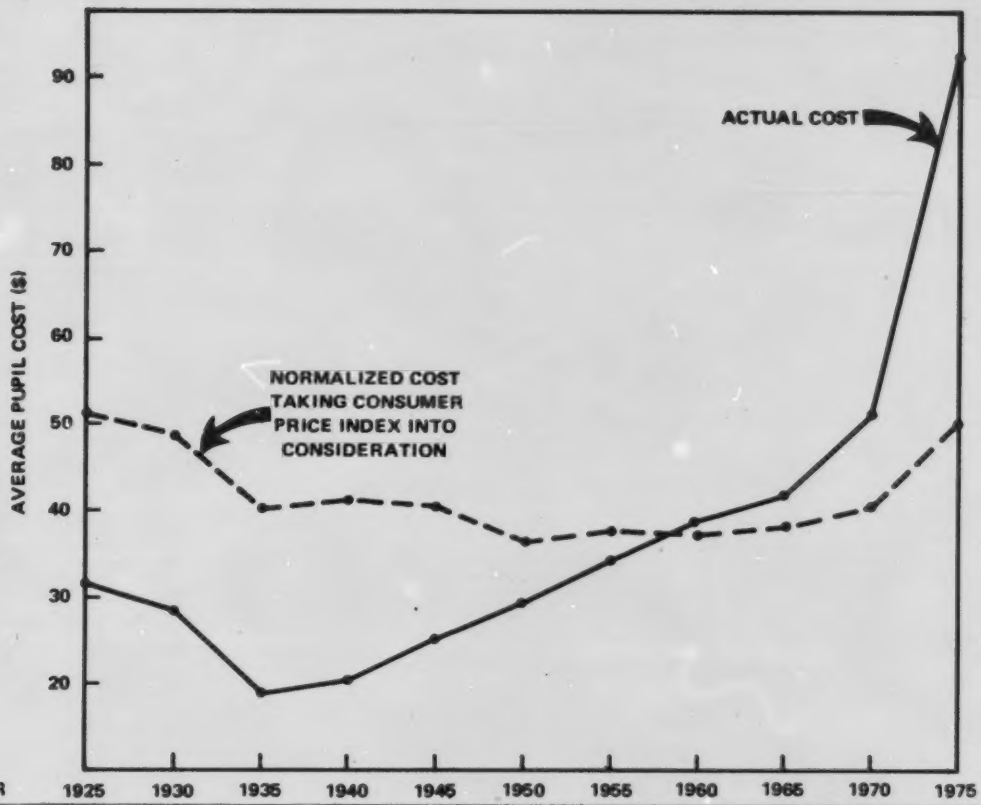
SOURCE: BRI SYSTEMS, INC. BASED UPON SURVEY DATA OF SCHOOL BUS OPERATIONS IN ELEVEN STATES. (REFER TO BIBLIOGRAPHY)

4.1 COSTS ARE A POWERFUL INCENTIVE FOR SAVING FUEL

Spiraling pupil transportation costs provide a great incentive for saving fuel in an era of very limited school budgets.

The following graph shows the actual and normalized national average costs for providing pupil transportation since 1925. Actual costs have continually increased since 1935; they have spiralled since 1970.

COST TRENDS IN PUPIL TRANSPORTATION: 1925-1975



YEAR	1925	1930	1935	1940	1945	1950	1955	1960	1965	1970	1975
CONSUMER PRICE INDEX	0.611	0.590	0.478	0.480	0.627	0.800	0.933	1.031	1.099	1.277	1.796

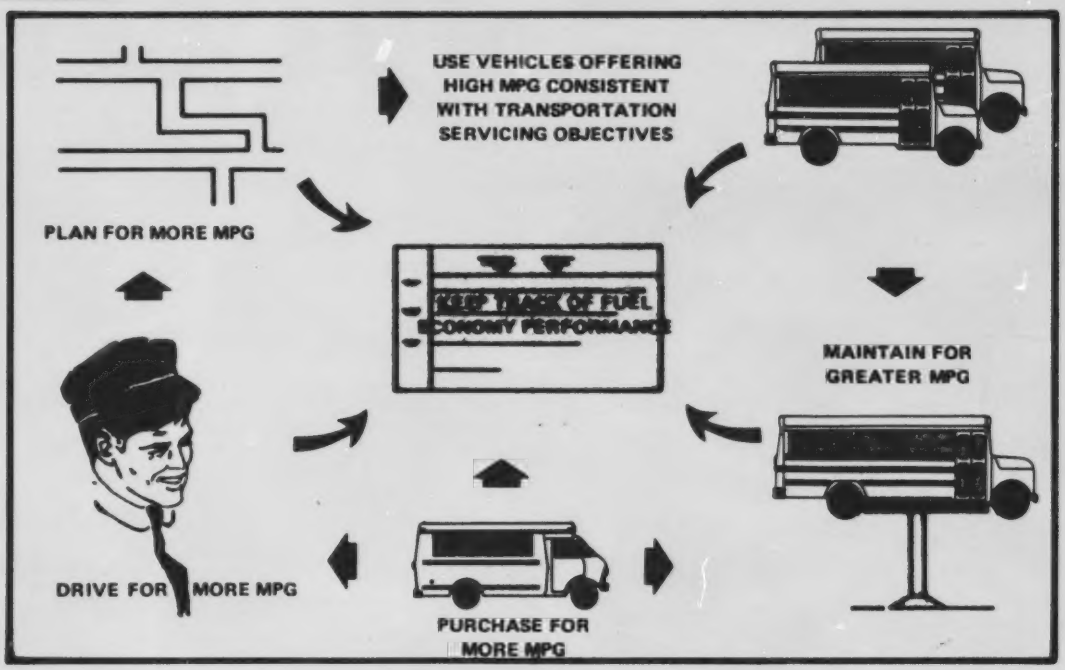
SOURCE: SCHOOL BUS VEHICLE SAFETY REPORT, U. S. DEPARTMENT OF TRANSPORTATION, WASHINGTON, D. C., PAGE II-2, 1977.

4.2 A FRAMEWORK FOR INCREASING FUEL ECONOMY

One specific set of rules for saving fuel is not applicable for every school district. Each school transportation fleet has its unique servicing characteristics and individual set of problems. On the other hand, common guidelines exist for increasing efficiency in all school districts.

The following pages present administrative measures that can increase fuel savings. Each transportation director should evaluate them. In many cases, the guidelines may represent an extension of programs and practices that are currently in use.

Taking the time and effort that are necessary to review fuel saving practices and transportation policies is an important first step in addressing energy management in the school district.


USE VEHICLES OFFERING HIGH MPG CONSISTENT WITH TRANSPORTATION SERVICING OBJECTIVES
PLAN FOR MORE MPG
KEEP TRACK OF FUEL ECONOMY PERFORMANCE
MAINTAIN FOR GREATER MPG
DRIVE FOR MORE MPG
PURCHASE FOR MORE MPG

4.2 A FRAMEWORK FOR INCREASING FUEL ECONOMY

Five types of measures can be taken to save fuel.

First, improvements in transportation system efficiency can be made. Take actions that increase vehicle occupancy and reduce vehicle miles-of-travel. Tips for this are presented on the following pages.

Second, place emphasis upon reducing vehicle fuel consumption. Purchase vehicles that offer more miles-per-gallon. Re-educate drivers to drive for maximum fuel economy. Review the important factors discussed in Chapter 5; make sure the driving staff is aware of their impact on fuel consumption.

Third, take advantage of opportunities to match equipment to servicing needs. This is discussed in Chapter 5, Part III and Chapter 9, Part V.

Fourth, more miles-per-gallon can be obtained and maintained by placing even greater emphasis upon the district's preventive maintenance program. Initiate policies that can increase the fleet's fuel economy; use modern equipment to help the staff save fuel. Chapter 9, Part V offers tips for saving fuel in planning, driving, and maintenance; it also discusses the role of purchasing for greater fuel economy.

Finally, keep your pupil-miles-per-gallon high by taking the time and effort to increase personnel skills. Conduct workshops and training programs. Make sure the staff is trained and motivated to save fuel. This is discussed in Chapter 9 (9.1), Part V.

**THE STAFF HAS A HIGH POTENTIAL
FOR OBTAINING MORE PUPIL-MILES-PER-GALLON.**

CREATE AN ATMOSPHERE OF KEEN

MANAGEMENT AWARENESS

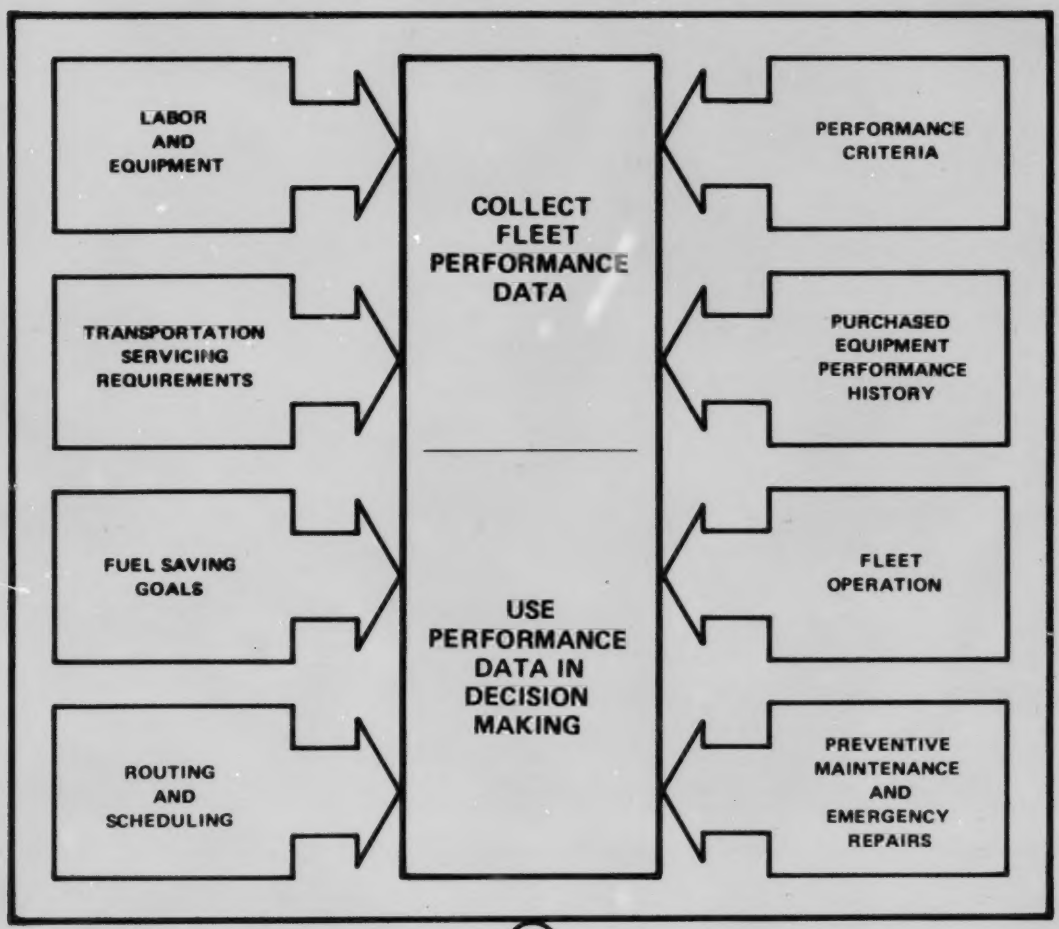
AND EXPECT THIS GOAL TO BE ACHIEVED!

4.3 SCRUTINIZING PUPIL TRANSPORTATION AT THE TOP

Transportation planning is performed within the framework of school administrative policies; these policies specify the criteria that should be met in pupil transportation. Use performance data as a basis for decision-making in updating your district's program to meet today's needs.

Identify, review, and evaluate the opportunities that exist to save fuel through policy changes--changes that can increase the effectiveness of the school transportation operation and save valuable dollars. Use the checklist on the following pages as a starting point. It offers tips that lead to fuel savings.

FLEET PERFORMANCE DATA OFFER A BASIS FOR DECISION-MAKING



4.3 SCRUTINIZING PUPIL TRANSPORTATION AT THE TOP

CHECKLIST OF ACTIONS THAT CAN BE TAKEN TO INCREASE FUEL ECONOMY

- [A] Analyze school district policies to see if they may actually condone transportation servicing inefficiency; identify areas that could result in fuel savings.
- [B] Begin a program to collect and record data on school bus fleet operation; use this data to evaluate opportunities for increasing fuel economy.
- [C] Coordinate reviews of school calendars and start-dismissal times; identify opportunities for increasing fleet servicing efficiency.
- [D] Develop recommendations to minimize unnecessary travel.
- [E] Encourage personnel to present ideas that can save fuel.
- [F] Foster an information exchange between your staff and other school districts; take advantage of what others have done to save fuel.
- [G] Get people involved; commitment and cooperation are important in saving fuel. Harvest the available "people energy" in your school district.
- [H] Hold workshops to solicit and share ideas to save fuel.
- [I] Increase the distance between student pick-up and drop-off points when feasible and safe to do so.
- [J] Jusitfy and re-evaluate administrative solutions that have been developed to meet transportation needs in the past. See if they can be improved.
- [K] Know why pupil transportation costs are increasing; look into the areas of cost increase and evaluate programs to reduce the cost of operation.
- [L] Limit co-curriculum trips in the district to full bus loads only; place restrictions on unnecessary trips.
- [M] Measure fleet performance and fuel use.
- [N] Notify the community of fuel conservation programs that are attractive; meet with the PTA to review and discuss opportunities to save fuel and dollars.

4.3 SCRUTINIZING PUPIL TRANSPORTATION AT THE TOP

CHECKLIST (CONTINUED)

- [O] Obtain outside assistance when necessary to review operation changes; get an objective veiwpoint and take advantage of practices used by other districts.
- [P] Provide incentives for saving fuel in the school district.
- [Q] Question route planning procedures; just because they worked in the past does not necessarily mean they will be of value in the future.
- [R] Review the district's purchasing procedures; make sure consideration is given to equipment that saves fuel.
- [S] Share equipment with neighboring districts for school events when possible to reduce bus use.
- [T] Take the time and effort necessary to educate, stimulate, and motivate district personnel to save fuel.
- [U] Use public mass transit for older students when it is feasible to do so.
- [V] Verify management practices that are implemented to save fuel; make sure they are being followed.
- [W] Weigh the total value of current programs; for example, can special education classes be consolidated in a way that would increase education benefits and reduce pupil travel.
- [X] X-ray vision is far better than hindsight; promote staff awareness of fuel saving methods.
- [Y] Yardsticks are important; establish guidelines for vehicle purchase, use, and trip distances.
- [Z] Zero-in on those areas where fuel can be saved. Take the necessary time and effort to achieve results.

CHANGE YOUR POLICIES TO MEET TODAY'S NEEDS !

PART III

UNDERSTANDING WHAT CONTRIBUTES

TO FUEL ECONOMY

PAIN MAKES MAN THINK.
THOUGHT MAKES MAN WISE.
WISDOM MAKES LIFE ENDURABLE.

JOHN PATRICK

5.1 SAVING FUEL IS A MANAGEMENT SCIENCE

Greater fuel economy is not obtained on the basis of hunches; it is achieved by becoming knowledgeable of and practicing techniques that reduce energy consumption. Using such techniques offers each school district a sound and practical framework for improving fleet performance.

The type of school bus purchased along with how well it is maintained, where it is driven, and how it is driven affects the fuel economy that can be obtained. This chapter briefly discusses the important factors that affect fuel economy. Review them and evaluate the opportunities to increase fuel economy through improved purchasing, routing, planning, driving, and maintenance actions.

Chapter 5 examines the variables the affect the fuel economy of every school bus in the fleet. One must first have an understanding of why the district's school buses may not be getting as many miles-per-gallon as the vehicles of other districts. Chapters 6-8 specify what your district can do about increasing fuel economy. How the district can do it is discussed in Chapter 9.

Management is an important part of the effort taken to increase fuel economy. The reasons for this are presented on the following page. A discussion of fuel wasting practices that can be corrected through purchasing and driving actions follows. Planning actions that save fuel are then presented. This is followed by a summary of steps to take to start saving fuel in school bus operation.

CONSULT THIS CHAPTER TO SEE WHAT AFFECTS FUEL ECONOMY. REFER TO CHAPTERS 6-9 FOR TIPS IN INCREASING FUEL ECONOMY.

5.1 SAVING FUEL IS A MANAGEMENT SCIENCE

Fuel economy management offers each school district an alternative for combating higher fuel prices. The management principles are unique in that they employ the best of both, Management-by-Objectives and Management-by-Exception principles.

In fuel economy Management-by-Objectives, specific and measurable objectives are established for each operating unit in the transportation department. The objectives are closely related to the long-range fuel saving goals of the school district. The district route planner, maintenance department, drivers, and all other operating units work toward meeting specific fuel saving objectives approved by the district.

Fuel economy Management-by-Exception is concerned with measuring the fuel economy performance of each vehicle in the fleet. Its purpose is to identify exceptions which will permit transportation department management to take immediate actions when problems arise.

Your district's program should be based upon scientific and economic factors: know how fuel can be saved and the dollar benefits that will be obtained in the school district in meeting the district's fuel saving goals and objectives. Apply the principles of these proven management techniques in your program to save fuel. Use sound principles to manage your program, modern equipment to monitor vehicle performance, and take advantage of available technology to plan and control your fleet's fuel use.

Every area in the transportation operation should contribute to meeting the school district's fuel saving goals. Management-by-Objectives provides a framework for planning, controlling, and measuring the results of programs initiated to obtain fuel and dollar savings. The reporting of fleet performance data provides a follow-up mechanism for signaling where problems are occurring and taking actions.

5.2 FACTORS THAT AFFECT VEHICLE FUEL ECONOMY

HORSEPOWER AND FUEL ECONOMY

An understanding of school bus fuel economy performance is based upon obtaining insight into the application of some fundamental principles which are concerned with determining the ability of the bus to perform useful work in an efficient manner. Horsepower is the rate at which the school bus performs the work. It represents a measurement basis for rating the performance of a school bus and indicates the amount of work that is done over a given time period. Horsepower is a measure of the maximum power that is available from the engine. The horsepower that is delivered to the clutch or its equivalent with all accessories functioning is referred to as a vehicle's net horsepower.

Horsepower and fuel consumption are related. The horsepower needed by a school bus to overcome all forms of resistance takes fuel. The total horsepower needed to power the school bus can be described as shown below, ignoring additional power demands for accessories, to overcome engine internal friction, weather, altitude effects, and poor road surface conditions. In sizing your school bus and its engine, at minimum, give consideration to the three important factors shown.

FACTORS THAT INFLUENCE FUEL ECONOMY

TOTAL POWER TO OPERATE THE SCHOOL BUS	=	POWER TO OVERCOME AIR RESISTANCE	+	POWER TO OVERCOME ROLLING RESISTANCE	+	POWER TO CLIMB GRADES

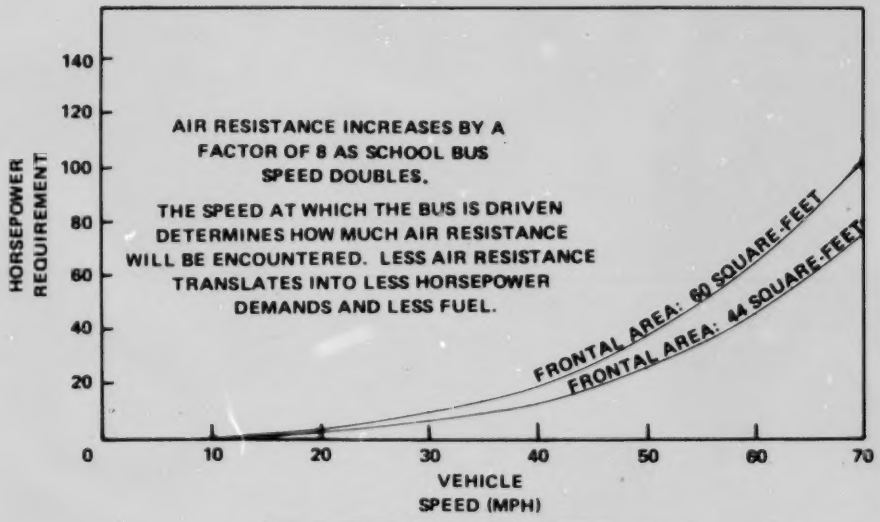
REVIEW YOUR VEHICLE'S POWER NEEDS. DON'T OVER PURCHASE! EXTRA POWER TRANSLATES INTO FUEL WASTE.

5.2 FACTORS THAT AFFECT VEHICLE FUEL ECONOMY

AIR RESISTANCE AND FUEL ECONOMY

As shown below, doubling a vehicle's speed increases the number of pounds of force which the air exerts against it by a factor of eight. Horsepower must be increased by this factor of eight to overcome the air resistance effects. The doubling of a vehicle's speed results in about a 17 percent or greater penalty in fuel economy(1); it also results in the consumption of additional oil(2).

RELATIONSHIP AMONG SPEED, HORSEPOWER TO OVERCOME AIR RESISTANCE, AND VEHICLE FRONTAL AREA



SOURCE: GENERAL MOTORS CORPORATION, TRUCK SELECTION, JAN., 1977.

TO REDUCE AIR RESISTANCE PURCHASE A SMALLER BUS • DRIVE SLOWER !

(1)U.S. Department of Transportation, The Effect Of Speed, October, 1973.
(2)Society of Automotive Engineers, Inc., Role Of Engine Oil Viscosity, 1966.

5.2 FACTORS THAT AFFECT VEHICLE FUEL ECONOMY

AIR RESISTANCE AND FUEL ECONOMY

Streamlined school buses that have rounded front and rear corners instead of being constructed in a squared-off box-shape manner reduce air resistance considerably. Tests have shown that streamlined vehicle designs can result in up to a 54 percent reduction in aerodynamic drag at higher speeds(3).

The horsepower needed to overcome air resistance demands is dependent upon the frontal area of the school bus, its speed, and the vehicle's drag coefficient; it can be approximately calculated by the relationship:

$$\text{HORSEPOWER TO OVERCOME AIR RESISTANCE}_{(4)} = \frac{\left[\text{VEHICLE CROSS-SECTIONAL FRONTAL AREA } (FT^2)\right] \times \left[\text{VEHICLE AIR SPEED (MPH)}\right]^2 \times \left[\text{VEHICLE ROAD SPEED (MPH)}\right] \times \left[\text{VEHICLE DRAG COEFFICIENT}\right]}{375}$$

High-speed driving increases the horsepower demands of the school bus. The engine of a vehicle having a frontal area of 60 square-feet has to generate less than one-horsepower to overcome air resistance effects at a speed of 10 miles-per-hour. The same engine must produce approximately an additional 10 horsepower to overcome air resistance effects at a speed of 30 miles-per-hour and almost 40 horsepower to overcome the air resistance when the vehicle increases its speed to 50 miles-per-hour in the same driving environment.

Purchase the smallest school bus that will meet the district's needs. Make sure that bus drivers are motivated to drive it at low-to-moderate speeds. These practices reduce air resistance and save fuel.

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(3)NASA Flight Research Center, Drag Reductions Obtained By Modifying A Box-Shaped Ground Vehicle, October, 1974.

(4)Example of drag coefficient is 0.002; vehicle air speed equals vehicle road speed plus (or minus) tailwind (or headwind).

5.2 FACTORS THAT AFFECT VEHICLE FUEL ECONOMY

ROLLING RESISTANCE AND FUEL ECONOMY

A tire's resistance to rolling is another factor that influences fuel economy. As a tire rolls, it flexes. This results in heat build up or rolling resistance. It forces the engine to work harder to overcome the flexing of tires and any irregularities present in the road surface.

The school bus must overcome greater rolling resistance when it is driven on an asphalt surface as compared to a concrete surface. The vehicle's rolling resistance further increases when it is driven on snow, gravel, or dirt surfaces. A patched up asphalt road or a gravel or dirt road will significantly reduce a vehicle's fuel economy. A road covered with snow can reduce a vehicle's fuel economy by as much as 1 mile-per-gallon(5). The following table shows typical fuel economy penalties that can arise from driving over such roads.

ROAD CONDITION EFFECTS ON FUEL ECONOMY

ROAD CONDITION	ESTIMATED MPG LOSS
Patched Asphalt	15%
Gravel	35%
Dry Sand	45%

Source: Environmental Protection Agency, Factors Affecting Automotive Fuel Economy, 1976.

(5)U.S. Department of Transportation, Effect Of Variation Of Speed Limits On Intercity Bus Fuel Consumption...And Corporate Profitability, November, 1975.

5.2 FACTORS THAT AFFECT VEHICLE FUEL ECONOMY

ROLLING RESISTANCE AND FUEL ECONOMY

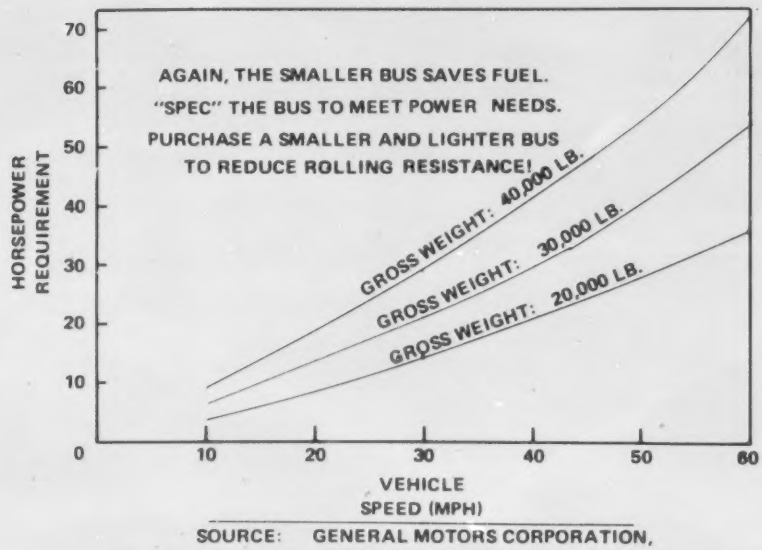
Vehicle weight and speed affects fuel economy. The additional horsepower needed to overcome rolling resistance forces is shown for three vehicles at varying speeds. The horsepower that must be produced by the engine to overcome rolling resistance may be computed as follows:

CALCULATING ROLLING RESISTANCE

$$\text{HORSEPOWER TO OVERCOME ROLLING RESISTANCE} = \frac{\text{VEHICLE SPEED (MPH)} \times \text{VEHICLE GROSS WEIGHT (LBS.)} \times \left\{ 6.75 + 0.074 \times \left(\text{VEHICLE SPEED (MPH)} \right) \right\}}{375{,}000}$$

Purchase the smallest bus that will meet the district's needs; purchase radial tires to reduce rolling resistance. Drive the vehicle at moderate speeds. These practices reduce rolling resistance and save fuel.

RELATIONSHIP BETWEEN SPEED, HORSEPOWER TO OVERCOME ROLLING RESISTANCE, AND GROSS VEHICLE WEIGHT



SOURCE: GENERAL MOTORS CORPORATION, TRUCK SELECTION, JAN., 1977.

(32)

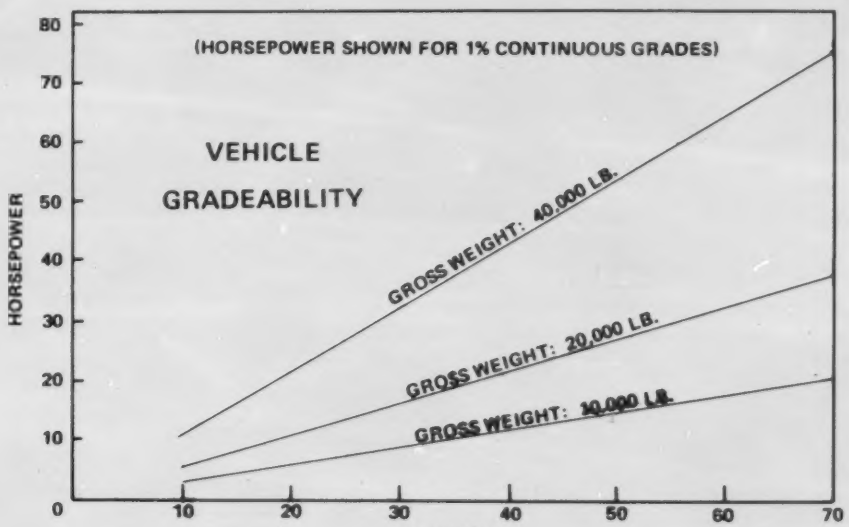
5.2 FACTORS THAT AFFECT VEHICLE FUEL ECONOMY

INFLUENCE OF GRADES AND HILLS ON FUEL ECONOMY: GRADEABILITY

Department of Transportation studies have shown that at 50 miles-per-hour, a bus weighing 36,000 lbs. will increase its fuel consumption by 29 percent driving up a continuous 1 percent grade(6). Hills create more of a fuel economy penalty at lower speeds than at high speeds. The performance of a school bus in climbing hills or its gradeability factor can be estimated by the following formula:

$$\text{HORSEPOWER TO OVERCOME GRADE EFFECTS} = \frac{\text{VEHICLE SPEED (MPH)} \times \text{GRADE (\%)} \times \text{VEHICLE GROSS WEIGHT (LB.)}}{37{,}500}$$

The following figure shows an example of the horsepower that is required for three vehicles to overcome grade resistance effects.



SOURCE: DEPARTMENT OF TRANSPORTATION; REFER TO FOOTNOTE NUMBER 6 BELOW.

(6)U.S. Department of Transportation, Effect Of Variation Of Speed Limits On Intercity Bus Fuel Consumption..., Profitability, NTIS No. PB-247-761.

5.2 FACTORS THAT AFFECT VEHICLE FUEL ECONOMY

ALTITUDE

The loss of power due to altitude changes for naturally aspirated engines is approximately 3 percent for every 1,000 feet of altitude increase(7).

POWER LOSSES

Other resistance demands which the engine must overcome include the power to drive accessories, transmission power train losses, axle losses, and internal resistance engine losses. Engine efficiency factors are discussed on the following pages. Further information about these factors is offered in Chapter 9 of the handbook; they must be given consideration in vehicle purchasing.

WEATHER EFFECTS

Cold weather lowers a vehicle's gas mileage since it requires longer time periods for the engine to warm up. Lubricants do not flow easily when the temperature is low. Once the moving parts warm up, fuel economy will still suffer because of cold air entering the engine. Environmental Protection Agency studies have shown that at a temperature of 20°F, fuel economy can be reduced by 11 percent or greater, as compared to operating the bus at temperatures of 40-50°F.

Winds also have an effect upon gas mileage. An 18 mile-per-hour headwind can reduce a vehicle's miles-per-gallon by as much as 17-20 percent.

**ONE CANNOT INFLUENCE THE WEATHER,
BUT ONE CAN INFLUENCE
THE AMOUNT OF POWER LOSSES !**

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(7)Fitch, J.W., Motor Truck Engineering Handbook, J.W. Fitch, Publishers, San Francisco, Cal., 1972.

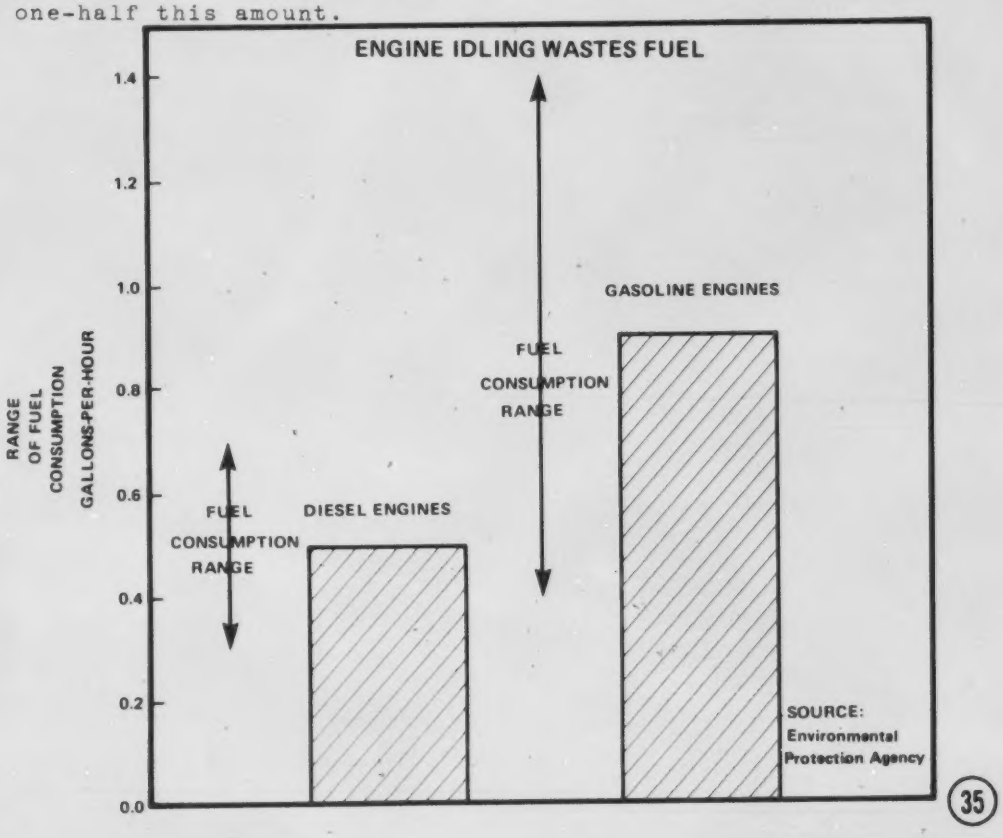
5.2 FACTORS THAT AFFECT VEHICLE FUEL ECONOMY

DRIVING HABITS

How a school bus is driven and where it is driven affect its fuel economy. Unnecessary braking is a fuel waster. This practice results in a large consumption of fuel because inertia must be made up to accelerate the school bus back to its cruising speed.

Changes in the inertia of a vehicle should be gradual to maximize fuel economy. Driving at a constant lower cruising speed, gradually accelerating, using the brakes sparingly, passing and merging in traffic smoothly--these habits result in less horsepower demand on the engine and more miles-per-gallon for the school bus.

Idling an engine also wastes fuel. If the bus is going to be stationary for more than one minute, fuel will be saved by shutting it off and restarting it rather than allowing it to idle. Under idling conditions, a gasoline engine can use almost 1 gallon of fuel per hour and a diesel engine about one-half this amount.



5.2 FACTORS THAT AFFECT VEHICLE FUEL ECONOMY

MAINTENANCE AND FUEL ECONOMY

Maintenance represents an area for significantly improving fuel economy. Simple actions can improve fuel economy from 5 to 10 percent. A spark plug in a gasoline-powered engine offers a typical example of such savings. One plug misfiring in a V-8 engine half the time at 55 mph will reduce gas mileage by 7 percent. Two plugs misfiring can result in a 20 percent fuel economy penalty(8). Making sure that the vehicle's tires have the proper inflation pressure is another simple but important action that can increase fuel economy. A preventive maintenance program that places emphasis on keeping the vehicle fleet operating at its potential peak efficiency will pay for itself in fuel, parts, and labor savings.

A SUMMARY OF FUEL SAVING STRATEGIES

Every school district can save fuel and dollars by purchasing equipment that will do the job most efficiently, planning routes to minimize fuel economy penalties, training and motivating drivers to drive for fuel economy, and providing a maintenance program that will keep the fleet in top notch mechanical condition. Chapter 9, Part V of this handbook offers guidance in developing fuel saving strategies to purchase for fuel economy, plan for fuel economy, drive for fuel economy, and to maintain for fuel economy. There are no compromises. Increased fuel economy is only achievable if the time and effort are devoted to obtain it.

**SOUND JUDGEMENT IS BASED ON EXPERIENCE.
TAKE ADVANTAGE OF WHAT OTHERS
ARE DOING TO SAVE FUEL AND REDUCE COSTS.**

(8)Based on Environmental Protection Agency tests and others documented by Douglas Aircraft Company, Vehicular Energy Conservation Program, March, 1975.

5.3 THE ENGINE AND FUEL ECONOMY

ENGINE EFFICIENCY

The engine is the heart beat of the school bus. It creates the power supply which is carried thru the clutch, transmission, drive shaft, differential, rear axle, and finally to the drive wheels.

Two basic types of engines are used in school buses: gasoline and diesel. The basic difference between them is the method of fuel ignition. In the gasoline engine, the fuel is ignited by a spark plug; in the diesel, it is ignited by compression.

Many factors influence engine efficiency. The number of cylinders, bore and stroke dimensions, and valve size are typical of such factors. Those which are more important to fuel economy are discussed below.

Air-fuel ratio is important in obtaining maximum efficiency. A mixture that is too lean or too rich can reduce the efficiency significantly.

Incorrect spark timing in gasoline engines can also reduce engine efficiency, by as much as 50 percent. Spark timing, generally controlled by a manifold vacuum and centrifugal advance, assures that proper ingition is achieved.

Higher compression ratios are also important to achieve greater engine efficiency. High ratios promote higher peak temperatures and greater conversion of a fuel's heat energy into mechanical work. This is one advantage of the diesel engine.

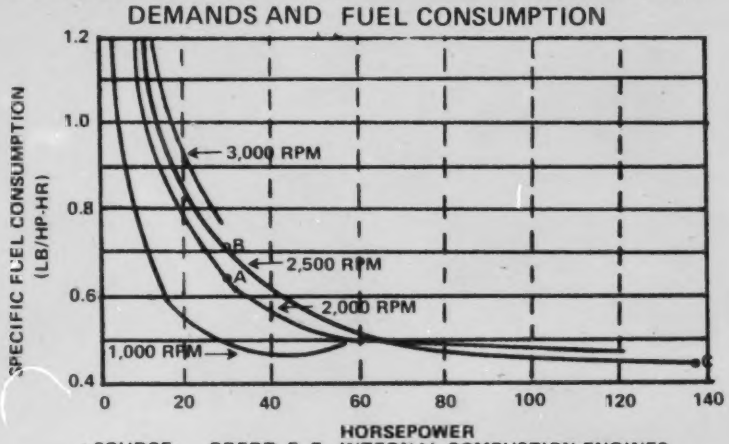
Engine speed and engine load factor also effect engine efficiency. This is discussed on the following page.

5.3 THE ENGINE AND FUEL ECONOMY

GASOLINE ENGINE EFFICIENCY FACTORS

As seen below, to obtain a given horsepower from a given gasoline engine, you will get better efficiency (and use less fuel) by running the engine at lower speeds. This is because higher engine speeds result in greater internal engine friction and throttling losses. Consequently, if you need 30 horsepower to move the school bus at 40 miles per hour, less fuel is consumed by staying in fifth gear at 2,000 rpm (Point A) than by shifting to fourth gear at 2,500 rpm (Point B).

RELATIONSHIP AMONG ENGINE SPEED, HORSEPOWER DEMANDS AND FUEL CONSUMPTION



SOURCE: OBERT, E. F., INTERNAL COMBUSTION ENGINES AND AIR POLLUTION, INTEXT EDUCATIONAL PUBLISHERS, NEW YORK, 1973.

A small engine operating at its governed speed and generating its maximum horsepower will use less fuel to generate that horsepower than will a larger engine producing the same horsepower at a lower load factor. As seen in the figure, the best specific fuel consumption (9) occurs at Point C, the maximum engine output. Fuel economy is maximized by selecting an engine for the bus which is near its maximum output during normal operation.

(9) Number of pounds of fuel consumed per horsepower-hour of work.

5.3 THE ENGINE AND FUEL ECONOMY

DIESEL ENGINE EFFICIENCY ADVANTAGES

Diesels are more efficient than gasoline engines for two reasons. They have a higher compression ratio and lower throttling losses.

Diesels use a lower cost, higher-energy fuel than their gasoline counterparts. Diesel fuel contains more energy than gasoline; it has more BTU's per gallon. Since the diesel engine has a much higher compression ratio, it burns fuel more completely and converts more of the available energy into needed vehicle horsepower.

In high-speed over-the-road operation a major reason for high diesel efficiency is its inherent cycle efficiency since throttling losses in a gasoline engine in these circumstances are slight. In around town stop-and-go operation, the throttling differences between diesels and gasoline engines are important. A diesel can get 30-35% better fuel economy than gasoline engines at high speeds and as much as twice their fuel economy in town. Overall a diesel can obtain anywhere between 40-70 percent better fuel economy in the driving environment which includes both high-speed and low-speed operation with many stops--a typical school bus operation in many communities that serve both urban and rural areas.

REMEMBER THESE RULES FOR GREATER FUEL ECONOMY:

1. **PURCHASE A SMALL AN ENGINE AS NEEDED TO POWER THE BUS.**
2. **RUN THE ENGINE AS SLOWLY AS IS POSSIBLE.**

DON'T BUY A 230 HP V-8 ENGINE WHEN A 150 HP 6-CYLINDER ENGINE WILL DO THE JOB!

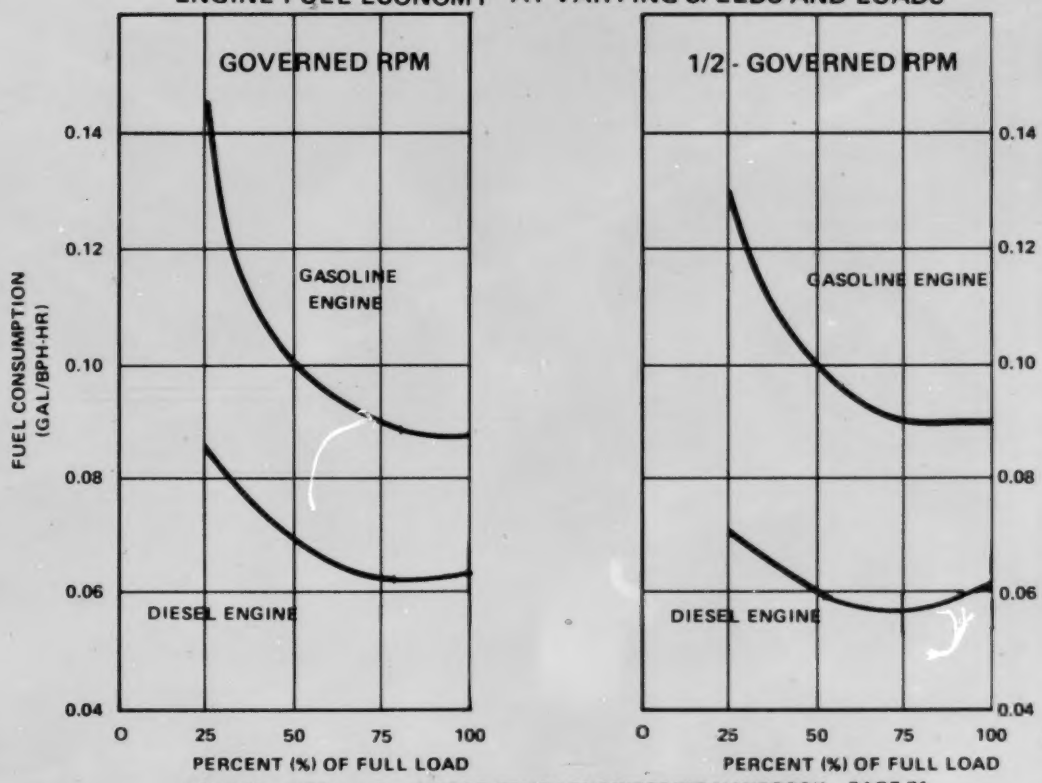
5.3 THE ENGINE AND FUEL ECONOMY

FUEL ECONOMY AND ENGINE SELECTION

The factors discussed in Section 5.2 should be considered in engine selection. Don't buy more power than you need. It will cost extra fuel and dollars. Ask dealers for assistance in specifying the engine requirements for your driving environment.

The question of engine selection--large or small, gasoline versus diesel--should be decided by weighing the fuel savings over the life of the school bus against the differences in purchase price and maintenance costs consistent with the financial investment objectives of the school district. Chapter 9.2 in Part V of the handbook provides guidance in this evaluation. Considering the many factors that affect fuel economy, it is important to select the smallest engine that will do the job.

ENGINE FUEL ECONOMY AT VARYING SPEEDS AND LOADS



SOURCE: FITCH, J. W., MOTOR TRUCK ENGINEERING HANDBOOK, PAGE 71.

5.4 A SUMMARY OF DO'S AND DONT'S

DO THE FOLLOWING

There are two ways by which the district's fleet can be upgraded to obtain better fuel economy: (1) equipment that offers increased fuel economy performance can be purchased, and (2) older equipment can be retrofitted with improvements. The installation of a temperature-sensing fan, a turbo-charging kit for diesels, radial tires, and engine derating are examples of vehicle retrofit actions that can be performed on the current fleet to obtain more miles-per-gallon. When selecting new vehicles, properly match and select the engine, transmission, and axle combination that will offer the best performance. Also give consideration to fuel saving options discussed in Part V of the handbook. Ask manufacturers and their representatives to offer recommendations to meet your district's specific needs. Compare comprehensively before you purchase. Refer to Chapter 9, Part V for tips in increasing the fleet's fuel economy.

DON'T FALL FOR RIP-OFFS

On the other hand, be aware of gimmicks sold in the marketplace which offer no fuel savings. When in doubt, check with reliable manufacturers, dealers, and school district peers. When evaluating claims of unknown products, make sure the tests that were conducted followed procedures specified by the Society of Automotive Engineers or other reliable professional sources. A list of reference sources is provided in Chapter 11, Part VII of this handbook. When in doubt about the benefits of claims made in the marketplace, request professional opinions and consultation.

MAKE THE MOST OF EACH DOLLAR.

PURCHASE FOR GREATER FUEL ECONOMY.

5.4 A SUMMARY OF DO'S AND DONT'S

A BRIEF CHECKLIST
OF FUEL SAVING ACTIONS

- ☐ Develop specifications for your bus purchases, specifications based on facts.
- ☐ Base purchasing decisions on fleet performance data.
- ☐ Derate engines of the current fleet if they have power to spare.
- ☐ Always select the smallest engine that will do the job.
- ☐ Specify a low numerical rear-axle ratio.
- ☐ Keep abreast of new equipment that saves fuel.
- ☐ Replace (or repair) buses that use excessive fuel as soon as at is economically feasible to do so.
- ☐ Refer to Chapter 9.2, Part V for additional tips in saving fuel and dollars.

PART IV

DEVELOPING YOUR SOLUTION TO THE ENERGY CRISIS

THERE IS NO SECURITY ON THIS EARTH.
THERE IS ONLY OPPORTUNITY.

MAJOR GEN. COURTNEY WHITNEY

6.1 IMPORTANT ELEMENTS OF THE DISTRICT'S FUEL ECONOMY MANAGEMENT PROGRAM

Policy Development

A fuel economy program starts at the top, but works at the bottom. Initially, it is imperative to develop fuel saving goals and common sense proposals to attain them. Fuel saving policy should be written and approved by the administration; the developed policy in turn should be acknowledged by all employees. Policy provides the mechanism for eliminating "loopholes," questions, and nonconformance.

Teamwork

The spirit of teamwork is what makes a ballclub great. The same spirit is important in saving fuel. Everyone must do their part to make school transportation a winner. Teamwork and coordination are important parts of the district's fuel economy management program.

Responsibility

One person should be charged with the responsibility for achieving fuel economy program goals. This individual should lead the groups involved in the team effort, maintain enthusiasm of the team, disperse information, periodically assess program progress, arrange for publicity to gain community understanding and support, and report on results.

A STRATEGY TO SAVE FUEL AND DOLLARS

DEVELOP THE POLICY TO GUIDE THE PROGRAM.

COORDINATE THE TEAM.

ASSIGN RESPONSIBILITY.

6.2 STEPS TO TAKE IN DEVELOPING YOUR PROGRAM

STEP 1: IDENTIFY FUEL SAVINGS GOALS

Outline the school district's fuel saving goals. Examples of such goals may include: "Zero growth in fuel consumption within three (3) years," "A twelve (12) percent cut in fuel use within two (2) years," and "A five (5) percent reduction in fuel use next year." Identify short-term and long-range goals that are desired to be met. Consult Section 6.3 (Chapter 6) for guidance in doing this.

STEP 2: REVIEW ADMINISTRATIVE POLICIES

Evaluate the feasibility of implementing policy changes that will help the school district to achieve its fuel economy goals. Examples of administrative policies that may be proposed are presented in Section 6.4 (Chapter 6).

STEP 3: REVIEW TRANSPORTATION OPERATIONS AND PRACTICES

Evaluate programs that can help to save fuel. Estimate the fuel and dollar savings that can be obtained by implementing the programs. "Implementing an equipment retrofit program to increase the fuel economy performance of the school bus fleet," "purchasing no school bus offering less than 9 miles-per-gallon," "incorporating a unit on fuel economy in the driver's training program," "improving the district's school bus routing program," "developing a maintenance records management system," and "purchasing diesel-powered buses" are examples of actions that can be taken to increase the fuel economy of the fleet. Refer to Section 6.5 for suggestions in doing this.

THE FIRST THREE STEPS ARE AN IMPORTANT PART OF FUEL ECONOMY MANAGEMENT. DEVOTE THE TIME AND EFFORT NECESSARY TO PERFORM THEM.

6.2 STEPS TO TAKE IN DEVELOPING YOUR PROGRAM

STEP 4: EVALUATE THE MEASURES THAT CAN BE TAKEN TO SAVE FUEL

Using the information obtained in performing the first three steps, evaluate the fuel saving ideas that were developed. Identify the merits of implementing them. Consult Section 6.6 for tips in doing this.

STEP 5: SET SCHOOL DISTRICT PRIORITIES

Lay out a plan for accomplishing the district's goals over a definitive time period using the results obtained in Step 4. Refer to Section 6.7 for ideas in developing the plan based upon the benefits to be obtained to the school district and the costs of implementation.

STEP 6: PREPARE THE DISTRICT'S FUEL ECONOMY MANAGEMENT PLAN

After the plan has been developed, it should be documented, reviewed, and approved. Any proposals that are necessary to implement it should be endorsed. Also identify program milestones at which time program results will be reviewed to determine if the district's desired goals are being achieved.

Specify the individual that is to be responsible for the district's fuel economy management program. Make sure that this person has both the responsibility for program implementation and the delegated authority to carry it out.

Chapter 7 discusses the steps that should be taken to implement the program. Certain efforts must also be initiated to keep the program effective. They are presented in Chapter 8.

AFTER COMPLETING THE SIX STEPS TO FUEL ECONOMY MANAGEMENT PROGRAM DEVELOPMENT, THE DISTRICT IS NOW IN A POSITION TO DO SOMETHING ABOUT REDUCING COSTS.

6.3 STEP 1: IDENTIFY FUEL SAVING GOALS

GENERAL GUIDELINES

Development and implementation of a fuel economy management program is not a "one-shot" effort. True effectiveness can only be achieved when management is continued on a year-round basis.

The time required for program implementation is relatively short. A few important actions must be performed to make sure that the program is off to the right start. Specification of the district's fuel and cost savings goals are the first step.

GOAL DELINEATION

Review vehicle use and fuel consumption in the district. If the transportation operation has been keeping vehicle performance records, this should be a relatively simple task. If not, this task should serve as a basis for recording vehicle performance data. Identify a set of goals based upon this review that would increase the effectiveness of pupil transportation. Look at areas where pupil-miles-per-gallon can be increased.

Establish three basic goals for the district:

1. A long-term fuel reduction goal to be met within a period of 4-5 years.
2. An interim fuel reduction goal to be met within a period of 2-3 years.
3. A short-term district goal desired to be achieved this coming year.

EVALUATING THE DESIRED GOALS

Evaluate each goal that has been set to make sure that it is practical and feasible. Hold a meeting between administrators and transportation department management to review the practicality of working towards achieving each goal.

6.4 STEP 2: REVIEW ADMINISTRATIVE POLICIES

ADDRESS SCHOOL DISTRICT POLICIES THAT AFFECT PUPIL TRANSPORTATION

Take the time to review the district's administrative policies that affect vehicle operation and costs. Evaluate the feasibility of changing outdated policies and recommending new policies that would promote an atmosphere leading to greater fuel economy.

Examples of typical policies that can affect fuel economy and costs are shown on the following page. Use the list as a starting point to evaluate policy changes that would reinforce the district's program to achieve its fuel economy management goals.

Review areas that make extra demands upon transportation in the district. Also identify the problems that could occur if new policies were implemented.

1. Review the checklist shown on the following page for fuel saving ideas.
2. Request the staff to present additional ideas which would lead to a more effective transportation operation.
3. Estimate the fuel and dollar savings that could be obtained by each change.
4. Estimate the costs of implementation.
5. Outline any problems that may occur.
6. Combine those policy changes that appear to be feasible with the recommendations developed in Step 3 and evaluate them as discussed in Step 4.

SEARCH FOR IDEAS THAT SAVE FUEL.

6.4 STEP 2: REVIEW ADMINISTRATIVE POLICIES

FUEL SAVING POLICIES THAT REDUCE COSTS

- ☐ Change the district's servicing boundaries to reduce transportation requirements. Review the opportunities to increase pupil servicing effectiveness with adjoining districts.
- ☐ Review the opportunities to reduce travel through school scheduling changes--beginning and ending times.
- ☐ Review all special programs. See if rescheduling or consolidation would result in pupil transportation and educational benefits.
- ☐ Increase student walking distances and strictly enforce them.
- ☐ Develop restrictions on travel. Eliminate pupil transportation during summer school. Encourage the use of public transportation when feasible and practical.
- ☐ Reduce the number of school field trips. Combine trips and limit them to full bus loads only.
- ☐ Establish minimum and maximum distances for field trips.
- ☐ Coordinate with other districts to share buses for athletic events.
- ☐ Encourage the riding of bikes.
- ☐ Increase the distance between student pick-up points to reduce the number of bus stops.
- ☐ Establish recommendations that require future school facilities to be constructed with fuel economy in mind; refer to Chapter 10.2, Part VI.
- ☐ Implement a fuel economy management program.

USE WRITTEN COMMUNICATIONS TO DOCUMENT YOUR STRATEGY TO AVOID MISINTERPRETATION AND CONFIRM AGREEMENTS.

6.5 STEP 3: REVIEW TRANSPORTATION OPERATIONS AND PRACTICES

OPERATION REVIEW

Request the staff to propose a list of ideas that can increase pupil transportation effectiveness in areas such as driver training, maintenance, routing, and vehicle scheduling. For each suggestion estimate:

1. Fuel and dollar savings that could be obtained.
2. Cost of implementation.
3. Time to implement the suggestion.
4. Problems that could arise in implementation.
5. Political feasibility and community acceptance of the fuel saving idea.

EQUIPMENT REVIEW

Review the district's equipment and identify those vehicles that are offering poor fuel economy performance. Use this review as a framework for keeping detailed records on each vehicle in the fleet. Develop a list that shows:

1. Fuel economy performance of each vehicle in the fleet.
2. Actions that can be taken to improve fleet performance.
3. Fuel and dollar savings that could be obtained by taking the actions identified.
4. Costs of implementation.
5. Time to implement.
6. Problems that could arise in implementation.

Address the questions on the following two pages to identify other areas where performance may be improved through fuel economy management actions.

6.5 STEP 3: REVIEW TRANSPORTATION OPERATIONS AND PRACTICES

OPERATIONS CHECKLIST

☐ Personnel Activities Review

- Are guidelines provided to the staff to encourage fuel economy? ☐
- Are procedures for saving fuel in writing? ☐
- Are bus drivers familiar with fuel saving techniques? ☐
- Are individual drivers aware of their fuel economy performance? ☐
- Are steps taken to improve performance? ☐
- Do supervisory personnel have a positive attitude towards improving performance? ☐
- Is there a unit on "driving for fuel economy" in the training program? ☐
- Are posters, handouts, pamphlets, and other media used to promote performance? ☐
- Is good performance recognized and rewarded? ☐
- Is good performance publicized? ☐
- Are personal letters written to employees to thank them for ideas that save fuel and dollars? ☐
- Are periodic meetings held to discuss performance? ☐
- Do employees participate in setting goals? ☐
- Are all employees involved? ☐
- Are employee suggestions soliciated and acknowledged? ☐

☐ Decision-Making Practices Review

- Do records offer a yardstick for taking actions? ☐
- Will vehicle records offer the district an early warning system for equipment replacement? ☐
- Does equipment retrofit and replacement decision-making take into consideration deterioration rates, equipment service life, fuel savings available over equipment service life, and present value benefits? ☐

6.5 STEP 3: REVIEW TRANSPORTATION OPERATIONS AND PRACTICES

OPERATIONS CHECKLIST (CONTINUED)

☐ Purchasing Practices Review

- Is fuel economy data used to influence purchasing decisions? ☐
- Are fuel and equipment purchased in unit loads (e.g., truckload gallons) whenever possible to take advantage of discounts? ☐
- Are buses the proper size for your needs? ☐
- Are the smallest least powerful buses that will do the job being purchased? ☐
- Are suppliers being asked for suggestions on how to increase fuel economy and reduce costs? ☐
- Is fuel saving equipment considered in purchasing? ☐

☐ Operation Review

- Are bus stops spaced as far apart as is feasible? ☐
- Are central collection points used whenever possible? ☐
- Are bus routes consolidated as much as is practical? ☐
- Are school athletic trips and field trips combined to maximize bus use? ☐
- Are bus routes re-evaluated periodically during the year to insure that equipment, labor, and time is used most effectively? ☐

☐ Equipment Maintenance Practices Review

- Are detailed equipment performance records kept? ☐
- Are standards used to measure performance? ☐
- Is fuel economy considered in routine maintenance (e.g., tire pressure, ignition timing, etc.)? ☐
- Are repetitive work orders for the same problems showing up? ☐
- Is there feedback and follow-up to each work order? ☐

6.6 STEP 4: EVALUATE THE MEASURES THAT CAN BE TAKEN TO SAVE FUEL

CONSTRUCTING THE VALUE ANALYSIS TABLE

Value analysis offers a method for comparing fuel economy management actions based upon the importance of benefits that can be obtained. Develop a list of criteria for measuring the value of each recommendation developed in the prior steps. The fuel economy value analysis table on page 55 shows examples of three criteria: dollar savings potential, probability of achieving the savings potential, and acceptability of each recommendation.

Each criterion should be assigned a "fixed" numerical value or criterion weight as shown in the fuel economy value analysis table. The numerical value that is assigned should be based upon the importance of the criterion to the district in meeting its fuel economy management program goals.

Using the format shown on page 55, develop the district's value analysis table showing criteria that will be used to evaluate the benefits of fuel economy actions that could be taken. Assign each criterion a numerical weight. Assume that the criterion weights will be represented by numerical values between 1 and 10. In the example discussed, the probability of achieving the savings potential is set at a value of 5. The savings that can be obtained if the action is implemented is very important, thus this criterion is assigned a value of 10. Community (political) acceptance of fuel economy actions is recognized as being important, yet we do not want to let this criterion highly influence any opportunities that may exist for significantly saving large amounts of fuel and dollars. Thus, this criterion is given a value of 3.

Using such a premise, we have now established the table for the decision-analysis. The following page discusses the method for evaluating each potential management action within such a framework.

6.6 STEP 4: EVALUATE THE MEASURES THAT CAN BE TAKEN TO SAVE FUEL

EVALUATING THE DISTRICT'S FUEL ECONOMY MEASURES

In the example on page 55, it is assumed that 6 management actions have been proposed in Steps 2-3 which could help the school district achieve the fuel economy goals developed in Step 1.

Management Action No. 1 (e.g., purchasing a new diesel-powered school buses) is estimated to save the district about $800 each year. It has an extremely high probability of being implemented and would be an acceptable solution to the community. It is given a numerical rating of 5 (average savings) to represent its cost-savings potential, and a value of 10 to represent its high probability of success and acceptance.

The grand total value of implementing Management Action No. 1 is 130. This is obtained by adding the individual weighted sums (e.g., savings potential: 50 = 5 x 10; probability of achieving the savings potential: 50 = 5 x 10; and community acceptability: 30 = 10 x 3).

Management Actions No. 2 thru 6 are analyzed in a similar manner. After each action has been evaluated, the grand total values for each are calculated and compared. In the example on page 55, Management Action No. 2 has the highest grand total value based upon the criterion weights assigned; it is identified as the most important (first) in the "preferred order ranking" column. Management Action No. 1 is the next best solution having a total grand value of 130. It is assigned a value of 2 in the "preferred order ranking" column. The grand total specifies how important each management action is as compared to all actions being evaluated.

The "preferred order ranking" column shows the importance of each potential management action to the district.

VALUE ANALYSIS TABLE FOR EVALUATING FUEL ECONOMY ACTIONS

MANAGEMENT ACTION NO.	CRITERION NO. 1 SAVINGS POTENTIAL CRITERIA RANK 1-10	WEIGHT (10)	TOTAL WT.	CRITERION NO. 2 PROBABILITY OF ACHIEVING THE SAVINGS POTENTIAL CRITERIA RANK 1-10	WEIGHT (5)	TOTAL WT.	CRITERION NO. 3 COMMUNITY ACCEPTABILITY CRITERIA RANK 1-10	WEIGHT (3)	TOTAL WT.
1*	5	10	50	10	5	50	10	3	30
2	6	10	60	10	5	50	10	3	30
3	2	10	20	8	5	40	10	3	30
4	8	10	80	6	5	30	2	3	6
5	6	10	60	3	5	15	8	3	24
6	2	10	20	6	5	30	8	3	24

DEVELOPING THE VALUE ANALYSIS TABLE

1. LIST CRITERIA OF IMPORTANCE TO THE DISTRICT.
2. ASSIGN EACH CRITERION A FIXED WEIGHT BASED UPON ITS IMPORTANCE.
3. ASSIGN A RANGE OF NUMERICAL VALUES FOR RANKING EACH MANAGEMENT ACTION UNDER EACH CRITERION.

USING THE VALUE ANALYSIS TABLE

1. RANK THE ACTION'S SAVINGS POTENTIAL.
2. RANK THE ACTION'S PROBABILITY OF ACHIEVING THE SAVINGS POTENTIAL.
3. RANK THE ACTION'S ACCEPTABILITY BY THE COMMUNITY.

MANAGEMENT ACTION NO.	GRAND TOTAL FOR EACH ACTION MANAGEMENT	PREFERRED ORDER RANKING
1	130	2
2	140	1
3	90	5
4	116	3
5	99	4
6	74	6

* IF MANAGEMENT ACTION NO. 1 IS TAKEN TO SAVE FUEL IT WILL PROVIDE A SAVINGS OF $800 ANNUALLY TO THE DISTRICT. ITS SAVINGS POTENTIAL IS AVERAGE (RANK = 5). THE PROBABILITY OF ACHIEVING THESE SAVINGS IS VERY HIGH (RANK = 10) AND THE ACTION WOULD BE HIGHLY ACCEPTABLE BY THE COMMUNITY (RANK = 10).

IN THE EXAMPLE, MANAGEMENT ACTION NO. 2 OFFERS THE MOST BENEFITS, BASED UPON THE 3 CRITERIA USED, FOLLOWED BY MANAGEMENT ACTIONS NO'S. 1, 4, 5, 3 AND AND 6 IN ORDER OF PRIORITY.

6.7 STEP 5: SET SCHOOL DISTRICT PRIORITIES

Using a table as shown on page 55, the district can evaluate each proposed fuel economy management action based upon such criteria as fuel and dollar savings potential, the probability of achieving the savings potential, community acceptability, implementation costs, and the estimated time to implement each action among other factors that are considered important to the district.

The management actions that have a higher numerical (grand total) value offer greater opportunities for saving fuel and dollars. This ranking is relative because the analysis consisted of a "first order" approximation. The district may now desire to perform a comprehensive benefit-cost analysis of the management actions that are ranked high to determine more exactly their true potential savings. Use the technique described on pages 81-88, Chapter 9.2, Part V in doing this. Rerank the management actions, as necessary, based upon the results of the benefit-cost analysis. This provides a sound basis for identifying a list of fuel economy management actions that can be promulgated. This list represents the foundation for the district's fuel economy management plan. Use this documented approach or another technique that can provide similar results in presenting the fuel economy program to management. The process results in definition of the priorities that should be placed upon each fuel economy management action based upon the importance of criteria to the school district.

6.8 STEP 6: PREPARE THE DISTRICT'S FUEL ECONOMY MANAGEMENT PLAN

Use the results of Step 5 to provide guidance in preparing the district's fuel economy management plan. The plan should specify precisely what will be accomplished to meet the short-term, mid-term, and long-term goals of the district. The plan should also identify the individual responsible for carrying out the overall program and all coordinators who will assist in program implementation.

Develop a planning schedule and document the budget required for plan implementation. Prepare a master schedule showing critical time points at which program results will be measured. Use this schedule as a means of communication in controlling the program. During implementation, do not expect everything to run smoothly. Problems can occur and individuals may fail to do what they are supposed to. The master program schedule should allow for program adjustments and be updated as necessary. As time moves on, a revised schedule may be developed reflecting these adjustments. Consideration of these important factors should be given in developing the district's fuel economy management plan.

At this stage, the district is now prepared to implement the plan. Chapter 7 provides guidelines for doing this.

FUEL ECONOMY MANAGEMENT GOALS ARE ECONOMIC GOALS.

GET PEOPLE TO THINK TOGETHER TO SPECIFY THEM.

JOINT HUMAN ACTION IS ESSENTIAL IN ACHIEVING THEM.

7.1 THE NECESSARY PUBLIC RELATIONS CAMPAIGN

THE DISTRICT'S FUEL ECONOMY PROGRAM OFFERS A BASIS FOR INCREASED SCHOOL-PARENT CONTACT

Public relations seeks to bring about a harmony of understanding between the school district and the public which it serves.

The school bus is the only contact that some people in the community may have with the school district. A well publicized fuel economy management program offers a framework for parent confidence in the school system. This is a valuable asset to school bus discipline and safety; it is also an asset in obtaining future school funds that must be approved by the taxpayers. A fuel economy program offers taxpayers a basis for having confidence in their school district and school transportation program. Such confidence affects their willingness to support future educational program needs. The community will appreciate steps that are taken to increase pupil transportation effectiveness and save dollars.

It is important to make the community aware of the steps that are to be taken to save fuel and the reasons for taking them.

PROMOTE YOUR DISTRICT'S PROGRAM THROUGHOUT THE SCHOOL AND COMMUNITY

SET SPECIFIC PUBLIC RELATIONS GOALS

HAVE ACTIONS AIMED DIRECTLY AT ACCOMPLISHING YOUR FUEL ECONOMY MANAGEMENT PROGRAM OBJECTIVES

APPRAISE PUBLIC RESPONSE

ALTER YOUR ACTIONS AS NECESSARY BASED UPON THE APPRAISAL

7.1 THE NECESSARY PUBLIC RELATIONS CAMPAIGN

Give ample thought to formulating a theme that will provide the setting for carrying out the district's fuel economy management program. Develop a message that can be used to promote the program throughout the community. Promote the message throughout the program using signs, posters, brochures, circulars, the student newspaper, press conferences, and available communication media. Decide on a theme that is simple, believable, informative, appealing, and which best supports the goals of the district.

Examples that could be used to promote the program include:

- o The 8.5 Miles-Per-Gallon Campaign.
- o Fuel Management To Avert Crisis.
- o The ——— School District's Fuel Economy Campaign.
- o Meeting ——— School District's Energy Challenge.
- o More Miles-Per-Gallon.
- o Sharing Energy Conservation Responsibilities.
- o Strategy For Fuel Economy.
- o Using Know How To Make Fuel Economy Work.

Plan a public relations campaign that will tell the community what the school district is going to do and why. Make the public aware of the rising costs of operation and the school district's program to help resolve these problems through management actions.

Design simple and inexpensive brochures that can be printed and distributed to promote the campaign. The district may also desire to contact their State Energy Office for other information that could be used in the campaign.

7.2 OBTAINING COMMITMENT AND COOPERATION

Commitment and assistance are required to kick off the program and to implement it. Maximum management effectiveness will be obtained by selecting one individual to head the program with support provided from subordinates and peers as deemed necessary to monitor and achieve results.

School administrators must be committed to the fuel economy goals and believe firmly in the management program. This is important in developing an overall spirit of cooperation.

The transportation staff, drivers, and maintenance personnel are the individuals who will be carrying out the program. In some instances, the district's program may require the introduction of new changes that may seek to alter personal habits that have been developed over many years. Personnel may look to these changes as a questioning of their capability. It is important to discuss the reasons why "the school district is going to do things differently." An effort must be made to point out that a purpose of fuel economy management is to reduce costs and that uncontrolled costs can affect jobs.

The clerical staff, teaching staff, and pupils are also an important part of the program. The clerical staff may be required to spend extra hours in helping to run the program--collecting data, creating posters, and assisting in other efforts. The teaching staff should be brought into the program during the review and planning stages. Get them involved and solicit contributions from them--communicate with the science department, auto shop, industrial education departments, and all teachers having special talents and skills that can be used in implementing the program. Students also play an important role in the program. This is discussed in Section 7.3.

7.2 OBTAINING COMMITMENT AND COOPERATION

THE PTA'S ROLE IN THE DISTRICT'S FUEL ECONOMY MANAGEMENT PROGRAM

Use the PTA as a mechanism for promoting the district's fuel economy management program throughout the community. Discus the reasons for the program with the PTA and point out the need for fuel and dollar savings in pupil transportation. Allow PTA members an opportunity to get involved during the planning phase--solicit ideas for saving fuel and reducing transportation costs from them.

WHAT THE PTA CAN DO FOR THE DISTRICT

Ask PTA members to survey their neighborhoods and present ideas that can reduce the demands made upon pupil transportation--less bus stops spaced farther apart and zone loading in each neighborhood are alternatives that could be reviewed.

Ask the PTA to promote fuel economy management in their meetings. Request ideas that can save fuel and that could improve transportation servicing in the district.

Have the PTA promote a district workshop on ways to save fuel. Let school district staff and parents join forces to discuss the opportunities for saving fuel.

OTHER IDEAS TO PROMOTE THE PROGRAM

Designate a Fuel Economy week. Send letters to Senators, Congressmen, the State Board of Education, the Department of Transportation, and other agencies and organizations asking for their cooperation and assistance. Make use of television, radio, and newspaper media to promote the district's program.

7.3 GETTING STUDENTS INVOLVED IN THE PROGRAM

IMPORTANCE OF STUDENT PARTICIPATION

The students of today are the individuals who will carry out the nation's energy management policies of tomorrow. Their participation in the fuel economy management program is beneficial to the district and to themselves. It offers them an opportunity to get involved in carrying out solutions to the nation's energy crisis; it also offers them an opportunity to learn good energy management habits.

AREAS OF INVOLVEMENT

There are many areas where students can get involved in the district's fuel economy management program. The list on the following page indicates some areas for student involvement. Identify areas for student involvement in the school during the planning steps and make these activities a part of the overall program.

Encourage participation of student class leaders during the latter stages of program planning. Use these individuals to help carry out the program.

ENCOURAGE STUDENTS TO PARTICIPATE IN THE SCHOOL'S PROGRAM TO SAVE FUEL. TELL THEM WHY SAVING FUEL IS IMPORTANT!

7.3 GETTING STUDENTS INVOLVED IN THE PROGRAM

A PARTIAL LISTING OF STUDENT PARTICIPATION PROGRAMS

- ☐ Initiate a school contest to identify fuel conservation practices.
- ☐ Start a campaign to have school buses compete with each other; measure fuel economy performance during the school year; post results on the school buses.
- ☐ Have students design "logos" and draw pictures which promote fuel economy--place the best ones on the front of each bus to remind the community of the program; refer to buses by names such as "the fuel saver," "the gasoline performer," and "the tortoise" rather than a number--names that can encourage fuel economy.
- ☐ Promote the fuel economy campaign in the school newspaper; let students contribute articles about fuel economy.
- ☐ Develop posters such as "keep engines in tune" and "don't waste fuel" and display them throughout the school.
- ☐ Hold a student contest for promoting ideas to reduce the number of bus stops in neighborhoods.
- ☐ Get students in industrial classes such as the auto shop curriculum involved in the program.
- ☐ Have the science club sponsor a project to save fuel.
- ☐ Have the transportation staff talk to students about practices that lead to better fuel economy.
- ☐ Hold periodic "fuel economy" meetings between drivers and students.
- ☐ Promote intradistrict and interdistrict fuel economy contests; encourage students and staff to apply fuel economy principles to their personal cars.

**USE THESE IDEAS AS A STARTING POINT
FOR STUDENT PARTICIPATION PROJECTS.
SEE HOW MANY OTHER IDEAS CAN BE DEVELOPED.**

7.4 PROGRAM KICKOFF

INITIATING FUEL ECONOMY MANAGEMENT IN THE DISTRICT

Coordinate program kick off to coincide with a PTA meeting. Hold a special assembly during the day for students and present the program that same evening to the parents. Be prepared to address questions with regard to why the program is being implemented and discuss how the district's goals were developed. Indicate why fuel saving practices are being implemented. Hold a press conference for the school and local newspapers and issue press releases.

HINTS FOR MORE EFFECTIVE PROGRAM PRESENTATION

The following ideas may be used to reinforce the district's kick off meeting:

1. Notify parents of the program in advance, via mailers or student handouts, to insure good attendance at the meeting.
2. Invite a guest speaker to discuss the opportunities for fuel economy management and the benefits to the district.
3. Provide a setting for the meeting--use visual aids and charts that the audience can relate to.
4. Issue a press release and hold a press conference.
5. Show an educational film on energy management; contact your State Energy Office for films.
6. Have members of the school board and transportation department present the school district fuel economy management program.
7. Have a teacher discuss the student projects that will be undertaken in the program.
8. Invite audience participation and questions.
9. Request community participation in the program.

PROVIDE THE MOTIVATION FOR FULL COMMUNITY COMMITMENT TO THE DISTRICT'S GOALS.

8.1 MONITORING RESULTS

Management efforts must continue after program initiation. The program should be monitored to make sure results are achieved. Two types of monitoring are required to keep the district's fuel economy management program effective. Each is separately discussed.

MONITORING OF ENTIRE SCHOOL DISTRICT RESULTS

The district's fuel economy management program should lead to a reduction of fuel use and costs. Review fuel use on a monthly basis and develop fuel consumption and cost data statistics as a management tool for program results measurement and feedback. Monthly monitoring will identify problem areas. Review and correct them. Revise the program schedule when necessary to make sure that it accurately reflects the status of all efforts being conducted.

MONITORING OF OPERATIONAL UNIT RESULTS

Make sure program responsibilities are being carried out in each area. In essence, this is nothing more than following the procedures of good management.

Review those areas where improvements are sought and closely monitor them. Results may not occur as quickly as expected. Do not panic. Find out the reasons for this. Motivate and inform personnel of corrective actions that can be taken to overcome problems.

Retain an atmosphere of commitment and total involvement. Do not allow set-backs to disrupt the program.

RECOGNIZE GOOD PERFORMANCE SO THAT IT CAN BE CONTINUED.

RECOGNIZE BAD PERFORMANCE SO THAT IT CAN BE CORRECTED.

RECOGNIZE CHANGES IN PERFORMANCE, GOOD OR BAD.

8.2 CONTINUING IMPROVEMENTS

PERSONNEL SKILLS

The area of fuel economy management is relatively new as compared to many other areas of management. In the coming months and years, new ideas and better equipment will be developed and made available to school districts. Keep abreast of the state-of-the-art. This can be encouraged by having transportation personnel become involved in national and state workshops and by promoting an environment of continual self-improvement in the staff. Keep in touch with organizations working in the field of fuel economy.

INCREASING FUEL ECONOMY MANAGEMENT PROGRAM BENEFITS

Keep an open mind for ideas to save fuel. Evaluate those that look promising. One of the indicators of a good management plan is that it is continually being updated and changed. This means that as people are working towards defined goals, they are identifying problems which were not anticipated. This is good. No one person can develop any one plan to solve all the complexities that exist in reducing fuel use in pupil transportation. Planning update is healthy. It leads to more effective transportation management.

READ THE TRADE PUBLICATIONS; KEEP ABREAST OF WHAT OTHERS ARE DOING TO SAVE FUEL.

PART V

GUIDELINES FOR INCREASING FUEL ECONOMY IN YOUR SCHOOL DISTRICT

IF MAN WILL BE CONTENT
TO BEGIN WITH DOUBTS,
HE SHALL END IN CERTAINTIES.

FRANCIS BACON, ADVANCEMENT OF LEARNING,
OXFORD DICTIONARY OF QUOTATIONS
OXFORD UNIVERSITY PRESS, 1959.

9.1 SQUEEZING EXTRA MILES FROM EACH TANK OF FUEL

INTRODUCTION TO FUEL SAVING ACTIONS

Chapter 9 is divided into five sections. The five sections discuss school transportation areas where opportunities are present to save fuel. Emphasis is on how fuel can be saved in each area.

Section 9.2 discusses purchasing actions that contribute to increased fuel economy. Taking the time and effort to "spec" fuel saving equipment is an important part of managing for greater fuel economy. Equipment purchases which couldn't be justified in the past can offer attractive paybacks today when current fuel, labor, and material costs are given consideration. The district's needs should be re-examined within the framework of today's economic climate.

The school bus driver also plays an important part in the district's fuel saving program. How a bus is driven and driver alertness to mechanical problems that could affect fuel consumption are important in getting optimum fuel mileage. Recommendations for motivating drivers to drive for better fuel economy are presented in Section 9.3.

Transportation planning tips are offered in Section 9.4. Planning and preventive maintenance, the latter discussed in Section 9.5, are other areas where more pupil-miles-per-gallon can be obtained.

The contributions that can be obtained in each area of pupil transportation will all collectively help the school district meet its fuel economy management goals and squeeze those extra miles from each gallon of fuel purchased.

MAKE ENERGY MANAGEMENT
A PART OF YOUR PROGRAM

9.2 PURCHASING TO INCREASE FUEL ECONOMY

IMPORTANCE OF THE PURCHASING FUNCTION

The school district purchasing function is the "money management" part of the operation. In general, administrators responsible for purchasing equipment do not personally use it, nor do they originate the request for its need. Yet, they can save the school district dollars by:

- Performing an economic analysis of equipment purchases.
- Grouping purchases to earn favorable prices, discounts, and deliveries.
- Ordering in lots that hold costs down.
- Purchasing to standardize the fleet as much as possible to minimize parts inventory problems and additional personnel training needs to service the fleet effectively.

Each school district dollar must be spent with the greatest of care. Because budgets are limited, purchasing practices should be re-examined to make sure that they are consistent with economics that lead to increased fleet performance.

Section 9.2 addresses two areas of the purchasing function that are important to fuel economy. First, decision-making questions are presented to help think out the purchasing steps. This is followed by a review of benefit-cost analysis methods that can be used to evaluate the district's equipment purchases. A summary of purchasing tips is presented at the end of this section.

REVIEW YOUR DISTRICT'S TRANSPORTATION NEEDS.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

QUESTION 1: BUS SIZING; SHOULD IT BE A LARGE OR SMALL VEHICLE?

Chapter 5 reviewed the important factors that affect a vehicle's fuel economy. Take advantage of the principles that were presented. Purchase the smallest bus that will adequately do the job for the purpose for which it is being bought.

Bus design characteristics such as size, frontal area and weight, and the speed at which the vehicle will be driven influence the amount of resistance (and fuel consumption) which will have to be overcome by power from the vehicle's engine. Do not overpurchase. Develop vehicle specifications based upon transportation servicing needs. Select the right vehicle for the right job.

Work closely with equipment dealers to specify the smallest bus that will best meet your district's servicing criteria such as those shown below in the most cost-effective manner.

FACTORS TYPICAL OF THOSE INFLUENCING BUS SPECIFICATION

- Number of pupils to be transported.
- Pupil age and physical condition.
- Fuel consumption performance.
- Average driving speed.
- Maximum speed to be driven.
- Distances to be traveled.
- Average road width and condition.
- Grades and hills to be encountered.
- Maintenance requirements.
- Average level of driver experience.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

QUESTION 2: SHOULD THE DISTRICT PURCHASE A GASOLINE OR DIESEL ENGINE?

Section 5.3 of Chapter 5 discussed the advantages of diesel engines. Diesel engines cost more because the engine block has to be designed to withstand higher forces of combustion and higher temperatures and pressures. Its fuel injection system is also more expensive than a carburetor.

The extra first cost to purchase a diesel engine should be compared against the benefits of obtaining more miles-per-gallon from a fuel that costs less than gasoline, about a nickel less a gallon, and reduced maintenance expenditures. Analysis methods that can be used to evaluate this tradeoff are presented on pages 81 thru 88.

The fuel and maintenance cost savings that were obtained from 73-passenger diesel school buses over similar sized gas models for surveyed school districts in the State of Washington are shown on the following page. The graph shows that diesel engines can offer substantial cost savings over their gasoline counterparts.

Survey data collected by the Regular Common Carrier Conference Maintenance Committee of the American Trucking Associations on eight commercial fleets operating similar sized diesel and gasoline powered vehicles showed similar results. Over the life span of each vehicle, the average annual costs of operation were about 40 percent less for diesel models(1).

Evaluate the fuel and maintenance savings of the diesel engine against the extra first-time purchasing cost, parts availability problems, and maintenance needs to service this engine in your area to answer this question.

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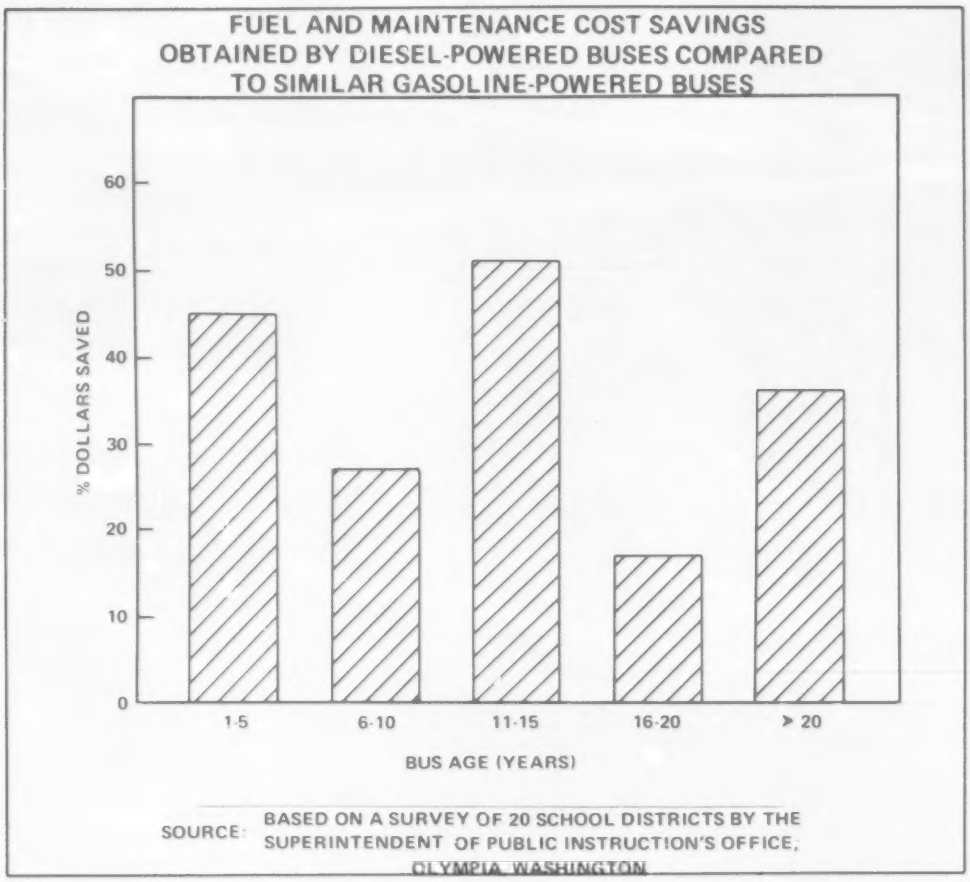
(1) Includes depreciation, fuel cost, fuel labor, overhauls, preventive maintenance, and repairs; based upon findings discussed in the Draft Report titled Interagency Study of Post-1980 Goals for Commercial Motor Vehicles, U. S. Department of Transportation, 1976.

9.2 PURCHASING TO INCREASE FUEL ECONOMY



After the vehicle has been sized to meet the district's needs, determine the engine power requirements. Equipment manufacturers can assist in calculating the total horsepower and required net horsepower that will be needed to power the school bus in your driving environment. Always purchase the smallest available engine that will meet these requirements.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

QUESTION 3: WHAT AVAILABLE REAR-AXLE RATIO SHOULD BE SELECTED FOR THE BUS?

The numerical axle ratio is a number that tells you how many times the vehicle's drive shaft must rotate to cause the vehicle's rear wheels to rotate one time. If the numerical ratio is 4.0, for example, the drive shaft must rotate 4 times to cause one complete revolution of the rear wheels. Determining which numerical rear-axle ratio is best for your bus should be done in much the same manner as selecting the right engine.

After the net horsepower to power the bus has been calculated, select an available rear-axle ratio that is nearest to the computed ideal ratio.

Gear ratios are available to meet a wide range of operating conditions. Lower numerical ratios will increase your vehicle's fuel economy; they may also place a limitation upon maximum vehicle speed due to a lack of power. Work closely with equipment dealers to calculate the ratio which will provide the best performance for your driving environment.

HAVE YOUR EQUIPMENT DEALER ASSIST YOU IN CALCULATING THE "IDEAL" REAR-AXLE RATIO FOR YOUR BUS IN YOUR DRIVING ENVIRONMENT. SELECT THE AVAILABLE NUMERICAL RATIO NEAREST TO THE "IDEAL."

9.2 PURCHASING TO INCREASE FUEL ECONOMY

QUESTION 4: WHAT TYPE OF TRANSMISSION WILL PROVIDE THE BEST PERFORMANCE?

Select the transmission and rear axle that will use available engine power most effectively. Take the time to properly mate this combination.

The choice between an automatic and a manual transmission is important in vehicle specification. The clutch which transfers power from the engine through a manual transmission to the drive train can be one of the most abused components in the school bus. The extra cost for an automatic transmission should be weighed against expenditures for replacing and maintaining the pressure plate, linings, throwout bearings, drive shaft, and the transmission, primarily when the school bus is being driven by drivers who are inexperienced in obtaining the benefits that are available from a manual transmission.

An automatic transmission reduces the engine lugging and overspeeding that frequently occurs from inexperience in operating a manual transmission. These factors are a common cause of engine damage; their prevention, along with potential fuel and maintenance savings that can be obtained from using an automatic transmission, may quickly pay for the additional first-cost of an automatic transmission.

REVIEW DRIVER EXPERIENCE LEVEL. SELECT THE TRANSMISSION THAT WILL OFFER THE BEST PERFORMANCE IN YOUR DRIVING ENVIRONMENT.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

Transportation managers in school districts and commercial trucking fleet operations have discovered that significant fuel and maintenance savings can be obtained from the use of automatic transmissions. The Springfield Township, Pennsylvania school bus fleet obtained operation and maintenance cost savings of about 20 percent for vehicles having automatic transmissions as compared to similar sized vehicles with a manual transmission in service between 1963-70. They have since obtained greater savings with the newer automatic transmissions(2). The Willoughby-East Lake City School District, Ohio, found their maintenance and fuel costs on diesel-powered buses having automatic transmissions to be about 50 percent less than similar sized gasoline-powered vehicles with standard transmissions(3).

Investigate and review the economics of automatic transmissions for the district's vehicle purchases. Better vehicle performance, increased durability, and easier driver handling are important elements in maintaining fuel economy. Ask equipment dealers for assistance in evaluating the economics of your transmission choice over the life of the equipment. Compare the operation and maintenance costs for each type of transmission over the equipment's life to answer Question 4 for your driving environment.

PURCHASE THE TRANSMISSION THAT WILL OFFER:

1. **LOWER OPERATING COSTS**
2. **BETTER SERVICING PERFORMANCE**
3. **REDUCED MAINTENANCE EXPENDITURES**

FOR YOUR DRIVING ENVIRONMENT.

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(2) Bobit Publishing Co., School Bus Fleet, June-July, 1977.
(3) Ibid., August-September, 1975.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

QUESTION 5: WHAT TYPE OF TIRES SHOULD BE PURCHASED?

Tires are important from two aspects. First, tire construction affects fuel use. At speeds below 55 miles-per-hour, tire rolling resistance consumes over half the horsepower produced by the engine. The rolling resistance of a radial tire is substantially lower than conventional tires. A radial tire can offer a 3-5 percent increase in fuel economy (4).

Tire replacement cost is a second factor to consider. Tire failures can account for up to 40 percent of road failures. Commercial trucking fleets have obtained operation and maintenance cost reductions by using steel-belted radial tires (5). The average fuel economy savings reported in 12 commercial fleets has been estimated at 4.3 percent (6). The Grossmont High School District in California has reported significant increases in tire life from its use of radials. The tires provided an average increased life of 50 percent over their conventional tires with exceptions having a 300 percent longer life (7).

Some fleets have experienced sidewall failure problems with certain radials. Join the trend of fleets converting to radial tires, but contact peers who have made the switch to make sure that a good tire selection is made.

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(4) U.S. Department of Transportation Draft Interagency Study of Post-1980 Goals for Commercial Motor Vehicles, Page VI-6, 1976; also refer to Federal Energy Administration transportation studies available from National Technical Information Service and Federal Energy Administration, Washington, D.C.

(5) Refer to fleet improvement discussions presented in Business Journals, Inc., Diesel Equipment Superintendent, Fuel Economy Issue, October, 1976.

(6) Diesel Equipment Superintendent, Fuel Economy Issue, October, 1976.

(7) Personal communications.

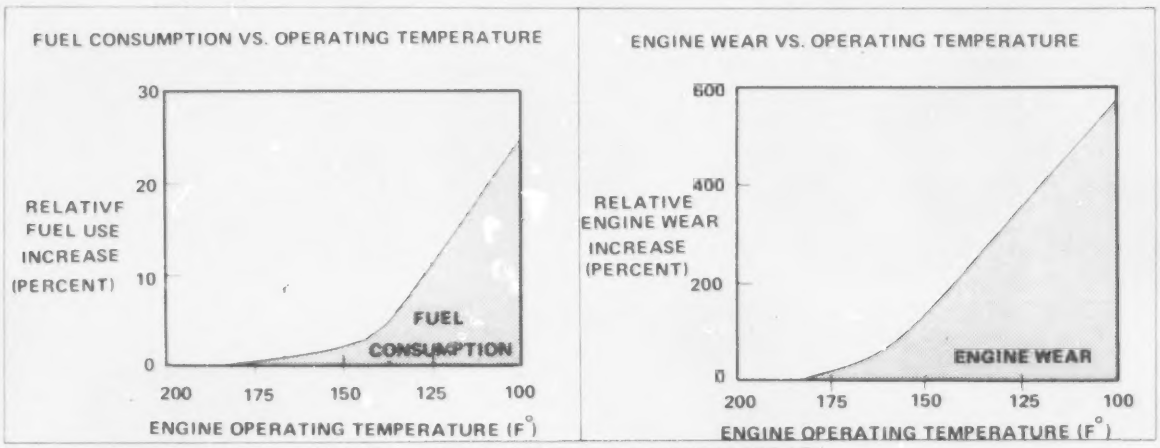
9.2 PURCHASING TO INCREASE FUEL ECONOMY

QUESTION 6: WHAT FUEL ECONOMY SAVINGS ARE OBTAINABLE FROM THE USE OF TEMPERATURE-CONTROLLED FANS?

As shown below, engine wear and fuel consumption are dependent upon engine operating temperature. In specifying the requirements for your school bus, a number of options are available to save fuel.

A cooling fan is only required part of the time during normal vehicle operation. Its operation uses engine power all the time. A fan clutch or temperature-modulated fan reduces power demands on the engine. Commercial fleet experience has demonstrated an average of 5-8 percent savings in fuel economy from using the automatic speed and viscous type fans. Consider these options in your purchases; they can also be installed on the current fleet.

Shutter devices are also available to help maintain optimal engine temperature. This option may be worth investigation for use in your fleet if temperature-control is a problem. High-temperature thermostats can also help the engine to operate in its most efficient temperature range for better fuel economy.



SOURCE: FUEL SAVINGS EQUAL BIG DOLLARS AT McDONNELL DOUGLAS, DIESEL EQUIPMENT SUPERINTENDENT, OCT., 1976.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

QUESTION 7: WHAT OTHER OPTIONS ARE AVAILABLE TO SAVE FUEL?

DERATING THE ENGINE

If school buses in the fleet have power to spare, consider derating the engines to save fuel. This is a simple procedure to reduce available horsepower and fuel consumption. Commercial fleet experience has demonstrated good fuel savings from this practice(8).

TURBOCHARGING

A turbocharged engine, available primarily on diesels, captures the waste exhaust gases and uses this energy to pack more air into the engine. Turbocharging improves engine performance and reduces fuel use. A turbocharger on a 240 horsepower naturally aspirated diesel engine has been shown to improve fuel economy by over 4 percent(9).

GOVERNORS

An engine speed governor limits the maximum engine speed that can be obtained. If the school bus is driven slower, this saves fuel. The use of a road speed governor can be an ideal solution when it is desired to reduce maximum vehicle speed without changing engine power availability.

This fuel saving equipment can be retrofitted to the current fleet. Do not overlook the opportunities for saving fuel by retrofitting the current fleet.

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(8) Refer to the publication prepared by Cummins Engine Co. and republished by the Federal Energy Administration: Trucker's Guide to Fuel Savings, March, 1976, for additional information. Also see the Federal Energy Administration publication FEA/D-77/068 which lists available Energy Conservation publications.

(9) Ibid.; 65,000 lb., 13.5-foot high tractor-trailer combination.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

QUESTION 8: WHAT OTHER EQUIPMENT IS AVAILABLE TO HELP THE DISTRICT SAVE FUEL?

Performance recording devices, alarms, and radio equipment can help to save fuel. Each is briefly discussed.

USE RECORDING EQUIPMENT TO PROVIDE PERFORMANCE DATA WHEN THE DRIVERS CAN'T DO IT ALONE

Recording devices do not save fuel directly. They provide a mechanism for monitoring engine efficiency and fuel use during vehicle operation. Analysis of engine performance data can provide insight into the type of driver education and training that may be needed to increase fuel economy in your school district.

Tachographs are typical of such equipment. They record vehicle speed or engine rpm. These charts can record driving periods from 12 hours to a full month. They may be used to record driver-vehicle performance characteristics such as excessive speed, sudden braking, engine lugging, and engine idling. These factors heavily influence fuel economy. This information is useful in helping the staff drive better by pointing out the mistakes that are made.

INSTRUMENTS CAN BE USED TO INDICATE OPERATION PERFORMANCE

Instrumentation is available to warn the driver when conditions occur that waste fuel. These systems cost between $50-$200; they may be used to monitor such things as oil pressure, intake manifold vacuum, fuel flow, and temperature. They help the driver save fuel by alerting him when dangerous or fuel wasting conditions occur.

CONSULT YOUR EQUIPMENT DEALER FOR INFORMATION ABOUT AVAILABLE INSTRUMENTATION THAT CAN HELP THE BUS DRIVERS SAVE FUEL.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

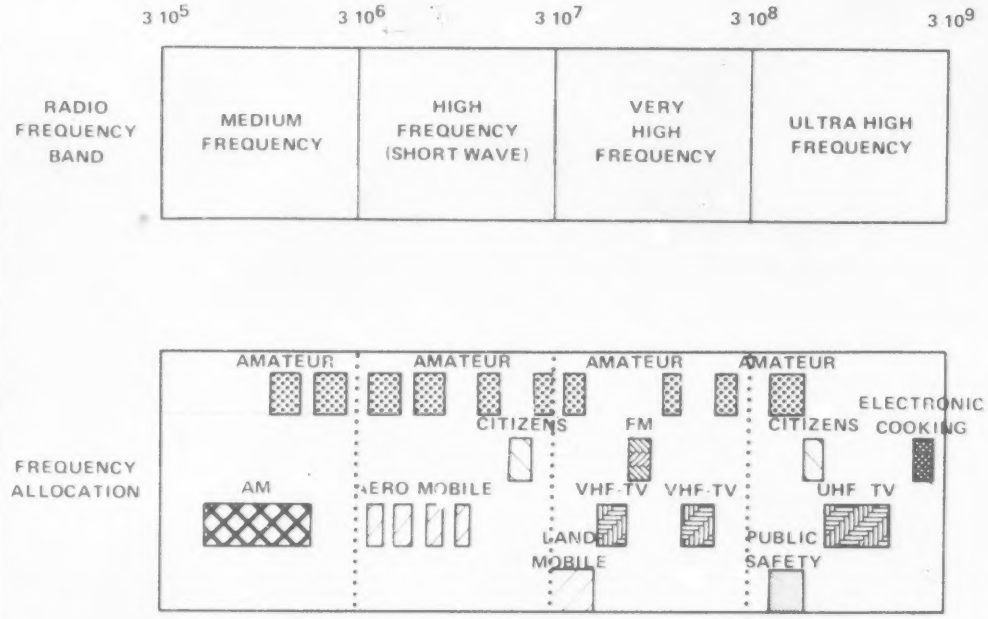
RADIO COMMUNICATIONS CAN HELP TO MAINTAIN BETTER FUEL ECONOMY

School buses can be equipped with a citizen's band (CB) radio for a cost of $125-$200 or with more expensive business-band FM systems running from $300-$1,000. The CB unit is less expensive, but its transmissions are more prone to static and interference than are FM transmissions.

Two-way FM equipment is more powerful than CB radios--from 10 to 100 watts or more as compared to a maximum of 4 watts for the CB unit. The license authorizes the school system access to one specific broadcast band resulting in exclusive or near-exclusive use of the channel, depending upon the area it is used in.

Two-way radios offer an opportunity for immediate dispatcher-driver communication and are valuable for re-routing and emergencies.

COMPARISON OF CITIZENS BAND (AM) AND FM RADIO FREQUENCIES



SOURCE: HIGHWAY RESEARCH BOARD, "RADIO SPECTRUM FREQUENCY MANAGEMENT," NO. 13, 1972.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

EVALUATING PURCHASING DECISIONS

In addressing Questions 1-8 on the prior pages, it will be found that numerous options are available for purchasing fuel saving equipment. Each option will require a different level of expenditure and in general, will not have the same useful life or benefits as other equipment which could be purchased. The district should evaluate and classify the investments, based upon their benefits and costs. The following pages offer guidance in performing the benefit and cost evaluations for each potential purchase. Use the methods presented to measure the worth of each fuel saving investment.

After investment worth has been determined, classify the investments and rank them in order of value to the district. The following criteria can be used in this classification.

INVESTMENT CRITERIA

CRITERION	ISSUE ADDRESSED
1. Degree of Necessity	1. How necessary is the investment to save fuel? Is it needed right away? How will it impact operation cost-savings?
2. Cash Outlay	2. How much cash is required for the investment? Is the cash available?
3. District Benefits Payback	3. How large are the savings? How quickly will the savings be returned?
4. Functional Unit Benefits Payback	4. How important is the investment for the operating unit to reach its energy saving goals?
5. Investment Risk	5. What uncertainties are present? What risks are associated with the investment?
6. Resource Availability	6. Does the investment require additional equipment, space or labor resources? Are the resources available?

9.2 PURCHASING TO INCREASE FUEL ECONOMY

FIRST LEVEL MEASUREMENT OF PURCHASING BENEFITS

Investment payback period (PP) and the return on investment (ROI) provide a first level of measurement indication about the value of each purchasing decision.

The equation for payback period is:

COMPUTING PAYBACK

$$PP = \frac{FC}{S}$$

where { FC = Investment First Cost Less Salvage Value ($)
S = Annual Savings ($)

The disadvantages of using payback period to evaluate fuel saving strategies must be recognized. They include:

1. No consideration to school district cash flow.
2. Neglect of the opportunity cost of capital.
3. Failure to discount costs occurring at different times to a common base for comparative analysis.

On the other hand the technique has advantages which include:

1. Provision of useful data for evaluation purposes.
2. Offers a good analysis framework for short time period investments.
3. Offers a basis for investment evaluation when the expected life of equipment is uncertain.

Return on investment may be computed by:

CALCULATING RETURN ON INVESTMENT

$$ROI = \frac{S - DP}{FC} \times 100\%$$

where DP = Annual Straight Line Depreciation ($) Over Equipment Life (L) Years

9.2 PURCHASING TO INCREASE FUEL ECONOMY

FIRST LEVEL MEASUREMENT OF PURCHASING BENEFITS

As an example in the use of the return on investment, assume that consideration is being given to the purchase of a diesel-powered school bus which has an additional first cost of $4,500 over its gasoline-powered counterpart. The investment data is summarized as follows:

INVESTMENT SUMMARY

1.	Additional first cost for diesel engine as compared to similar horsepower gasoline engine for the selected school bus:	$4,500
2.	Added salvage (trade-in) value of diesel over gasoline powered bus:	$1,000
3.	Period of analysis (straight line depreciation):	7 Years

Assume the school bus will be driven 12,000 miles annually. Fuel savings are estimated at 825 gallons each year as shown:

FUEL COST SAVINGS THIS YEAR

ITEM	GASOLINE MODEL	DIESEL MODEL	SAVINGS
Average Yearly Fuel Used (Gallons) (10)	2,000	1,175	825
Fuel Cost (11)			
Nontaxable Fuel @ 57¢/gal	1,140	-	-
Nontaxable Fuel @ 52¢/gal	-	$ 611	-
Estimated Yearly Fuel Savings	-	-	$529

Vehicle downtime and maintenance savings are estimated as $571 annually.

ANNUAL MAINTENANCE SAVINGS

Maintenance (Labor & Materials) Based On $4,000 Over 7 Years (12)	$571

(10) Urban-Suburban driving environment assumed.
(11) Enter your fuel costs here when performing the analysis.
(12) Assumes diesel will run 50,000 miles between top end inspections and 125,000 miles or more between major overhauls.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

FIRST LEVEL MEASUREMENT OF PURCHASING BENEFITS

The annual dollar savings for the example discussed total $1,100.

	ESTIMATED AVERAGE ANNUAL SAVINGS
Fuel Savings	$ 529
Other Savings	$ 571
Total Savings	$1,100

Using the information presented on pages 82-83, the pay-back period for purchasing the diesel-powered bus is (13):

$$PP = \frac{FC}{S} = \frac{\text{First Cost - Salvage}}{\text{Savings}}$$

$$= \left[\frac{\$4,500 - \$1,000}{\$1,100}\right] = 3.2 \text{ Years.}$$

The (yearly) straight-line depreciation value is (13):

$$DP = \frac{FC}{L} = \left[\frac{\$4,500 - \$1,000}{7 \text{ Years}}\right] = \$500.$$

The return on investment is calculated as:

$$ROI = \frac{S - DP}{FC} \times 100\%$$

$$= \left[\frac{\$1,100 - \$500}{\$3,500}\right] = 17.1\%.$$

The purchase of a diesel engine for the school bus looks attractive; it will be evaluated in greater depth on the following pages.

ENERGY CONSERVATION PURCHASES ARE AMONG THE MOST ATTRACTIVE INVESTMENTS THAT THE SCHOOL DISTRICT CAN MAKE.

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(13) Value of the diesel engine; note that you should use your depreciation schedule for the computation.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

SECOND LEVEL MEASUREMENT OF PURCHASING BENEFITS

Second level purchasing analysis incorporates an allowance for the time value of money in the form of a discount factor. A dollar held today is worth more than a dollar held in some future time period because of the use of that dollar between now and the future. Present worth analysis(14) offers a way to evaluate future savings in terms of today's dollars.

Present worth analysis offers a method for evaluating benefit-cost ratios (B/C) for the district's investment. The formula for calculating the benefit-cost ratios of fuel conservation investments is shown below. Examples of uniform present worth factors used in the calculation are shown on page 88.

The internal rate of return (IRR) can be computed to determine the discount rate. Similarly, school administration may specify discount rates based upon such criteria as borrowing (interest) rates for financing the investment.

BENEFIT-COST ANALYSIS

$$\frac{B}{C} = \frac{\text{Benefits}}{\text{Costs}} = \frac{\text{Uniform Present Worth (\$)}}{\text{First Cost (\$)}}$$

or

$$\frac{B}{C} = \left[\frac{\text{Annual Savings (\$)} \times \text{Present Worth Factor}}{\text{First Cost (\$)}} \right]$$

(14) Also referred to as Present Value Analysis; the term "Present Worth Analysis" is used so as not to confuse the reader with the "Value Analysis" technique presented in Part IV.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

SECOND LEVEL MEASUREMENT OF PURCHASING BENEFITS

Recognizing that fuel prices will increase in the future, the benefit-cost ratio equation should be modified to take this into consideration. The average annual fuel cost increases over equipment life can be determined by the following relationship.

$$\begin{Bmatrix}\text{Average Annual Fuel Cost Over Investment Period (\$)}\end{Bmatrix} = \begin{Bmatrix}\text{Average Fuel Price This Year (\$/Gallon)}\end{Bmatrix} \times \begin{Bmatrix}\text{Fuel Price Increase Multiplier}\end{Bmatrix}$$

The fuel price increase multiplier is computed as follows:

$$\text{Fuel Price Increase Multiplier} = \left[\frac{(1+f)^N - 1}{f \times N}\right] \left(\begin{matrix}\text{Reference} \\ \text{page 88}\end{matrix}\right)$$

where

f = Estimated Annual Fuel Price Increase (%)

N = Analysis Period (Equipment Life) Years

The benefit-cost ratio equation shown on page 85 may be written as follows to incorporate the fuel cost considerations:

BENEFIT - COST ANALYSIS METHOD
GIVING CONSIDERATION TO FUEL PRICE INCREASES

$$\frac{B}{C} = \frac{\left(\left[\begin{matrix}\text{Annual Fuel Savings} \\ \text{(\$)}\end{matrix}\right] \times \left[\begin{matrix}\text{Fuel Price Increase} \\ \text{Multiplier}\end{matrix}\right] + \left[\begin{matrix}\text{All Other Average Annual Savings} \\ \text{(\$)}\end{matrix}\right]\right) \times \left[\begin{matrix}\text{Present Worth} \\ \text{Factor}\end{matrix}\right]}{\left[\begin{matrix}\text{First Cost} \\ \text{(\$)}\end{matrix}\right]} \qquad (15)$$

---

(15) Average annual fuel savings = annual fuel savings (saving this year) x fuel price increase multiplier. Also note that First cost = investment first cost less salvage value.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

SECOND LEVEL MEASUREMENT OF PURCHASING BENEFITS

The uniform present worth analysis method may now be used to calculate the benefit-cost ratio for the example presented on pages 82-84.

Assuming a discount rate of 5 percent, the present worth factor is determined to be 5.786 for a 7 year lifetime (refer to the table on page 88(16)).

An annual fuel price increase of 12 percent is projected over the 7 year analysis period. The fuel price increase multiplier to represent the average fuel price based upon the projected increases over the analysis period is computed to be 1.44 as shown below(17).

$$\text{Fuel Price Increase Multiplier} = \left[\frac{(1+.12)^7-1}{(.12) \times (7)}\right] = \left[\frac{2.21-1.0}{.84}\right] = 1.44$$

The first year fuel savings total $529. Maintenance cost savings are estimated to total $571 annually (see page 83). The first cost of the investment, less salvage value, is equal to $3,500 (refer to page 83). Entering these value into the benefit-cost ratio equation on page 86 results in:

$$\frac{B}{C} = \left[\frac{(\$529 \times 1.44 + \$571) \times (5.786)}{\$3,500}\right]$$

$$= \left[\frac{(\$1,333) \times (5.786)}{\$3,500}\right] = \frac{\$7,713}{\$3,500} = 2.20.$$

The purchase represents a profitable investment and will return $2.20 in savings to the school district for each $1 invested in purchasing the diesel-powered bus.

---

(16) Use the formula shown on page 88 to calculate present worth factors (PWF) for other discount rates not shown in the table.

(17) Refer to the fuel price increase multiplier on page 88 .

9.2 PURCHASING TO INCREASE FUEL ECONOMY

UNIFORM PRESENT WORTH FACTORS

LIFETIME (L)	DISCOUNT RATE (D) 1%	5%	10%	15%
1	0.990	0.952	0.909	0.870
2	1.970	1.859	1.736	1.626
3	2.941	2.723	2.487	2.283
4	3.902	3.546	3.170	2.855
5	4.853	4.329	3.791	3.352
6	5.795	5.076	4.355	3.785
7	6.728	5.786	4.868	4.160
8	7.652	6.463	5.335	4.487
9	8.566	7.108	5.759	4.772
10	9.471	7.722	6.145	5.019
11	10.368	8.306	6.495	5.234
12	11.255	8.863	6.814	5.421
13	12.134	9.394	7.103	5.583
14	13.004	9.899	7.367	5.725
15	13.865	10.380	7.606	5.847
16	14.718	10.838	7.824	5.954
17	15.562	11.274	8.022	6.047
18	16.398	11.690	8.201	6.128
19	17.226	12.085	8.365	6.198
20	18.046	12.462	8.514	6.259
25	22.023	14.094	9.077	6.464
30	25.808	15.372	9.427	6.566
35	29.409	16.374	9.644	6.617

$$\text{PRESENT VALUE} = \frac{(1+i)^N - 1}{i(1+i)^N}$$

Use the formula for rates not shown in the above table

WHERE
- i = DISCOUNT RATE
- N = INVESTMENT PERIOD

FUEL PRICE INCREASE MULTIPLIER VALUES

ANALYSIS PERIOD YEARS (N)	ESTIMATED ANNUAL PRICE INCREASE 4%	8%	12%	16%
3	1.04	1.08	1.12	1.17
5	1.08	1.17	1.27	1.38
7	1.13	1.27	1.44	1.63
10	1.20	1.45	1.75	2.13
15	1.33	1.81	2.49	3.44

REFER TO PAGE 86 FOR FUEL PRICE INCREASE MULTIPLIER EQUATION.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

SUMMARY OF PURCHASING TIPS

Review the district's transportation operation to determine where new equipment purchases may increase fuel economy. Consider diesel powered, automatic transmission school buses with turbocharger options that use radial tires to help the school district obtain optimal fuel economy when economically feasible. Also review the opportunities for retrofitting the current fleet by taking advantage of fuel saving options such as engine derating, radial tires, and temperature-modulated fans among other measures that were discussed. Compute the benefit-cost ratio for each fuel economy investment and rank the investment.

Tips that can help the district hold down costs in an era of spiraling inflation include:

1. Purchase diesel-powered school buses.
2. Look at the opportunities for further increasing diesel fuel economy by purchasing a turbocharger.
3. Review the benefits of radio communications.
4. Consider derating engines of the current fleet if vehicles have power to spare.
5. Make use of governors when necessary to save fuel.
6. Specify a fan clutch or temperature-modulated fan to reduce engine power demands.
7. Consider a high-temperature thermostat or shutters for your school bus to help keep the engine in the high efficiency operating range.

PURCHASE A SMALLER BUS!

9.2 PURCHASING TO INCREASE FUEL ECONOMY

SUMMARY OF PURCHASING TIPS: CONTINUED

8. Use radial tires.
9. Perform a benefit-cost ratio analysis to evaluate equipment purchases.
10. At minimum, compare fuel savings payback and return on investment of equipment purchases.
11. Develop specifications for the purchase of all equipment that uses energy.
12. Do not purchase inferior equipment to save money if it uses more energy.
13. Purchase the smallest bus with the smallest engine offering the most efficiency that fulfills transportation needs.
14. Select school buses with streamlined frontal designs whenever possible.
15. Select the smallest engine that is adequate for your district's power needs.
16. If possible, select an engine-vehicle combination that can be easily and inexpensively maintained and which offers the best fuel economy for your driving environment.
17. Specify a low numerical rear-axle ratio.
18. Select only the power accessories necessary for security and safety.
19. Purchase instrumentation if the drivers cannot do it alone.
20. Don't buy gasoline with octane higher than is necessary to eliminate knocking.
21. Select the transmission that offers the best performance in your driving environment.
22. Use maintenance and fuel economy historical information for decision-making.
23. When practical, order parts and supplies in volume to obtain the best price.
24. If you have a small fleet, combine purchases with other districts to gain "purchasing power."
25. Purchase fuel by the truckload to obtain discounts.

9.2 PURCHASING TO INCREASE FUEL ECONOMY

SUMMARY OF PURCHASING TIPS: CONTINUED

26. Base all purchase decisions on fleet performance data.
27. Standardize the fleet as much as possible to allow for better inventory control and volume purchases; this also may reduce maintenance training needs and result in better vehicle servicing.
28. Have a used bus checked by a diagnostic center before purchasing; include fuel economy considerations as selection criteria.
29. Inventory parts and order for a full school year on a planned basis to obtain the best price.
30. Keep abreast of new equipment that saves fuel.
31. Retrofit the fleet to save fuel; the retrofit of an electronic ignition system is an example of fuel saving practices.
32. Replace or repair buses that use excessive fuel as soon as it is economically feasible.

PURCHASING IS AN IMPORTANT PART OF FUEL ECONOMY MANAGEMENT.

MAKE THE MOST OF EACH DOLLAR.

PURCHASE WISELY.

PURCHASE FOR FUEL ECONOMY.

9.3 DRIVING FOR OPTIMUM FUEL ECONOMY

DRIVER ATTITUDES AND FUEL ECONOMY

Driver motivation is a very important element in the district's fuel economy management program. School bus drivers, for the most part, are not highly trained specialists who have spent several years in preparation for the task that they must perform. Yet, they can make up for this with a proper attitude and "behind the wheel" experience. By exercising good common sense and having a sincere desire to save fuel, they can be highly successful in driving safely and in squeezing more miles from each gallon of fuel if they are properly instructed and motivated. Attitude is the difference between success and failure.

The driving staff should be trained to use techniques that offer improved fuel economy. Incorporate a unit on "driving for increased fuel economy" in the training program. Each driver must accept the responsibility for the vehicle assigned--a very special and very expensive vehicle. Provide drivers with the knowledge and motivation to drive safely and to conserve fuel.

This section offers tips for motivating and training the district's school bus drivers to drive for more miles-per-gallon. Driving practices that lead to greater fuel economy are listed on the following pages. These practices can be incorporated into a unit on "fuel economy" in the driver training program. Provide your bus drivers with the information they need to drive for more miles-per-gallon; motivate them to drive safely and to drive for greater fuel economy.

9.3 DRIVING FOR OPTIMUM FUEL ECONOMY

DRIVER MOTIVATION

Motivation is an important part of obtaining and maintaining optimum fuel economy. Review the following tips for keeping driver motivation at a high level.

TIPS FOR MOTIVATING DRIVERS TO DRIVE FOR GREATER FUEL ECONOMY

- ☐ Re-examine the driver training program; bring it up to date to meet the district's fuel economy management goals and objectives.
- ☐ Develop a spirit of friendly competition among drivers; discuss this in the driver training program.
- ☐ Post weekly or monthly vehicle and driver fuel consumption lists; give drivers recognition for a job well done.
- ☐ Post a chart comparing current fuel savings to the district's fuel economy management goals. Show the staff how much fuel has been saved.
- ☐ Use driver progress reports as a mechanism for keeping motivation high.
- ☐ Place fuel economy literature in pay envelopes on a periodic basis.
- ☐ Publicize good performance; give the drivers recognition.
- ☐ Appreciate good performance; thank drivers for a job well done.
- ☐ Solicit ideas from drivers to improve fuel economy performance in the school district.

**EXPECT MORE. THE DRIVERS CAN DO IT.
GIVE THEM REASONS TO DRIVE
FOR GREATER FUEL ECONOMY.**

9.3 DRIVING FOR OPTIMUM FUEL ECONOMY

An impromptu meeting held each morning before drivers start their runs, or at least once a week, is a good vehicle for discussing both fuel economy and safety problems. Drivers live in different parts of the community. Such a meeting allows for discussion of weather conditions, detours, road hazards, and other factors that can affect fuel economy and safety. This meeting also provides an opportunity for drivers and supervisors to discuss other issues of importance.

DRIVER-VEHICLE RESPONSIBILITIES

THAT SHOULD BE A PART OF EVERY MANAGEMENT PROGRAM.

- ☐ Practice a regular program of daily vehicle inspection using prescribed procedures.
- ☐ Make sure that oil and water levels and tire inflation pressure are proper and that no loose wires or hoses are present.
- ☐ Listen for trouble--make sure that the engine sounds right and no unusual noises occur.
- ☐ Feel for trouble--make sure the brakes hold the vehicle and it accelerates properly.
- ☐ Look for trouble--check all gauges to make sure they are reading correctly.
- ☐ Smell for trouble--make sure no unusual odors are present.
- ☐ Be mentally alert.
- ☐ Be physically alert.
- ☐ Report any occurrence of a vehicle problem.
- ☐ Last, but not least, drive defensively and drive to save fuel.

9.3 DRIVING FOR OPTIMUM FUEL ECONOMY

"FUEL ECONOMY" AS A PART OF THE DRIVER TRAINING PROGRAM

The driver is with the bus every day and is the person most likely to notice faulty vehicle operation which can increase fuel consumption. Drivers can prolong the mechanical life of each bus by making maintenance aware of problems.

Emphasis upon driver re-education to increase fuel economy expertise pays numerous dividends. The more knowledge drivers have about their equipment and the fundamentals of operation, the better position they are in to drive for maximum fuel economy.

MANAGEMENT TIPS FOR HELPING DRIVERS SAVE FUEL.

- ☐ Re-educate drivers to use techniques that lead to increased fuel economy; refer to Chapter 5 to review the factors that affect fuel economy.
- ☐ Hold workshops with maintenance and driver personnel on a periodic basis to consolidate fuel saving knowledge.
- ☐ Train new drivers while the bus is "dead heading" to save fuel.
- ☐ Enforce a maximum speed limit.
- ☐ Make drivers aware of the fuel economy penalties of unauthorized stops.
- ☐ Make drivers aware of the fuel economy penalties due to unnecessary engine idling.
- ☐ Develop incentives for reducing vehicle fuel consumption in your operation.
- ☐ Post fuel consumption results; recognize performance.

INCENTIVES AND EMPLOYEE RECOGNITION FOR A "JOB WELL DONE" ARE AN IMPORTANT PART OF FUEL ECONOMY MANAGEMENT.

9.3 DRIVING FOR OPTIMUM FUEL ECONOMY

"FUEL ECONOMY" AS A PART OF THE DRIVER TRAINING PROGRAM

Incorporate a unit on driving for better fuel economy into the training program and test driver skills in the road test.

The criteria that allow a vehicle to obtain increased fuel economy are similar in many respects to the basic skills that are needed to drive more safely. All School bus drivers should be examined to make sure that they have mastered these skills.

SCHOOL BUS DRIVER ROAD TEST SKILLS THAT LEAD TO FUEL SAVINGS

- Pre-trip inspection--checking equipment that affects fuel consumption such as oil level and tire inflation pressure.
- Starting and stopping the vehicle--having skills to accelerate and decelerate gradually.
- Driving maneuvers--passing, turning, and driving at as constant a speed as is possible to maximize vehicle miles-per-gallon; looking ahead to avoid dangerous and fuel wasting situations.
- Stopping--shutting the engine off when the bus will be stopped for more than 1 minute.
- Driving speeds--maintaining speeds that are safe and result in more miles-per-gallon.
- Post-trip--recording fuel consumption and reporting problems.

PROVIDE THE PERSPECTIVE FOR DRIVING SAFER AND FOR DRIVING TO GET MORE MILES-PER-GALLON.

9.3 DRIVING FOR OPTIMUM FUEL ECONOMY

TIPS IN STARTING THE SCHOOL BUS

- ☐ Always remember the pre-driving inspection check--look for trouble, feel for trouble, smell for trouble, and listen for trouble.
- ☐ Drive away soon after turning on the engine; prolonged "warm up" is not necessary. Drive slowly until the engine warms up. Maximum fuel economy cannot be obtained until the engine has warmed up.
- ☐ Gradually increase speed--jack rabbit starts are fuel wasters and can harm the engine.
- ☐ Run through the low gears gently, but quickly, into the higher gears which are the most efficient fuel economy range.

SHIFTING FOR MORE MILES-PER-GALLON

- ☐ Don't lug the engine--this places a severe strain on components such as bearings and cylinder walls and results in premature engine wear.

TYPICAL MILES-PER-HOUR TO BE REACHED BEFORE UPSHIFTING OR DOWNSHIFTING

1 to 2 Gear	7-15 M.P.H.	5 to 4 Gear	30-35 M.P.H.
2 to 3 Gear	10-15 M.P.H.	4 to 3 Gear	15-20 M.P.H.
3 to 4 Gear	20-25 M.P.H.	3 to 2 Gear	5-10 M.P.H.
4 to 5 Gear	30-40 M.P.H.	2 to 1 Gear	Stop

Note: MPH will vary slightly depending on the engine make, transmission, gear ratio, and terrain.

Source: California School Bus Handbook, 1976.

- ☐ Don't skip gears when upshifting with a load.
- ☐ Shift into higher gears as soon as possible without lugging the engine.

9.3 DRIVING FOR OPTIMUM FUEL ECONOMY

TIPS IN DRIVING FOR FUEL ECONOMY

- Observe speed limits; keeping the vehicle's speed low offers safety and fuel economy benefits.
- Drive slowly on unpaved roads and roads with sharp projecting stones.
- Drive slower on curves.
- Drive defensively and brake sparingly--every time the brake is applied, inertia is reduced and extra fuel is required to bring the vehicle back up to cruising speed.
- Keep proper distance between the bus and the vehicle in front of it; driving too close is a safety hazard, it also necessitates extra braking demands.
- Drive at a steady and as near as constant a speed as is practical. Keep an eye on traffic far ahead of the bus to help plan ahead.
- Change lanes smoothly, don't pump the gas pedal unnecessarily.
- Don't ride the clutch--never use it to hold the vehicle on an incline by slipping it.
- When approaching a hill, build up speed gradually, but early and maintain it until the vehicle is near the crest--reduce it and let the potential energy of the vehicle power it to maintain speed.
- Use the same practices when driving back to the bus terminal that you would use when transporting pupils.

MAKING DRIVING FOR FUEL ECONOMY A PERSONAL CONTEST.

9.3 DRIVING FOR OPTIMUM FUEL ECONOMY

TIPS IN STOPPING THE SCHOOL BUS

- ☐ If the bus is going to be stopped for more than 1 minute, shut the engine off.
- ☐ Never speed up the engine before turning off the ignition.

RECORD KEEPING AND FUEL ECONOMY

Accurate measurements are an important part of obtaining and maintaining good fuel economy. Record fuel use daily--to the nearest tenth of a gallon if possible.

Try to have the fuel tank filled up to the same level each time. Also try to have the bus in the same position during fill ups. This will allow more accurate gas mileage information to be recorded.

Today's fuel tanks are irregular in shape and can contain air pockets. Fuel use should be recorded daily, but it is better to calculate fuel consumption over a span of at least three to five fill-ups to make sure the possibilities of error are reduced.

Use the following table as a guide for recording fuel economy. Compare the economy in subsequent weeks. A frequent check of the miles-per-gallon will identify potential problems and indicate when the engine is not performing at peak efficiency.

DRIVE SLOWER!

9.3 DRIVING FOR OPTIMUM FUEL ECONOMY

FUEL ECONOMY RECORD

VEHICLE _____ DRIVER _____

PERIOD READINGS	ODOMETER READING (MILES)	FUEL (GALLONS)	OIL (QUARTS)
PRIOR READING	(1)		
DATE _____	_____	_____	_____
DATE _____	_____	_____	_____
DATE _____	_____	_____	_____
DATE _____	_____	+ _____	+ _____
DATE _____	(2) _____	Carry Over To New Sheet	Carry Over To New Sheet
TOTALS		(3) _____	(4) _____
PERIOD READINGS			
DATE _____	(1) _____	_____	_____
DATE _____	_____	_____	_____
DATE _____	_____	_____	_____
DATE _____	_____	+ _____	+ _____
DATE _____	(2) _____	Carry Over To New Sheet	Carry Over To New Sheet
TOTALS		(3)	(4)

MILES DRIVEN = (2) _____ - (1) _____

FUEL (GALLONS) = (3) _____

$$\text{FUEL ECONOMY} = \frac{\text{Miles Driven}}{\text{Fuel (Gallons)}} = \_\_\_\_\_ \text{ MPG}$$

OIL USED = (4) _____

$$\text{OIL ECONOMY} = \frac{\text{Miles Driven}}{\text{Oil Used}} = \_\_\_\_\_ \text{ MPQ}$$

CONSULT THE U. S. DEPARTMENT OF TRANSPORTATION PUBLICATION SERIES FUEL ECONOMY THROUGH TEAMWORK, PUBLICATION NO. 3, FOR POCKET-SIZED RECORDING GUIDES.

9.3 DRIVING FOR OPTIMUM FUEL ECONOMY

ADDITIONAL TIPS TO INCREASE SCHOOL BUS MILES-PER-GALLON

1. Maintain a steady, soft foot on the gas pedal.
2. Don't pump the gas pedal.
3. Observe the speed limit. Don't speed.
4. Accelerate smoothly from a stop and when changing speeds.
5. Anticipate stops.
6. Watch traffic far ahead so you can plan traffic moves early; use the brakes sparingly.
7. Never ride the brake or clutch.
8. Merge smoothly; time vehicle approaches.
9. Adjust driving methods to road conditions.
10. Minimize or eliminate engine warm-up time.
11. Drive slowly during engine warm-up periods.
12. At intersections on a hill use the brake instead of the clutch to hold position.
13. When starting uphill use the brakes to prevent rolling backwards.
14. Don't start the engine until everyone is ready to go; avoid jackrabbit starts.
15. Don't "rev up" the engine before turning off the ignition.
16. Turn off all power consuming systems before turning off the ignition.
17. Shut off the engine if the vehicle is going to be stopped for more than one minute.
18. Think fuel economy.
19. Avoid fuel spilage when refueling buses.
20. Maintain patience, courtesy, and good humor.
21. Make driving a personal contest; try as many fuel economy operating techniques as possible.

9.4 PLANNING TO INCREASE FUEL ECONOMY

BUS ROUTING AND SCHEDULING

Routing and scheduling represent areas where many gallons of fuel and capital outlay dollars can be saved in operation. Routing analysis is a highly complex operation for the average school district. Effective routing of school buses requires much time and effort to evaluate the interrelationships of the factors listed on the following page. Good routing practices are based on three principle factors: safety, efficiency, and fuel economy. Scheduling similarly, represents the key to transportation system effectiveness in conjunction with defining the optimum routes.

Each route should be designed to load each bus to legal capacity. Pupil age, health, and physical condition, along with trip distances, road conditions, school schedules, and Federal and State Government regulations have to be given consideration in route design and in matching the vehicle to the route.

Pupil loading and unloading points should be designated so that they support pupil transportation efficiency in a safe and economical manner.

ROUTING AND SCHEDULING ARE THE MECHANISMS THAT MAKE FUEL SAVINGS GOALS A REALITY.

9.4 PLANNING TO INCREASE FUEL ECONOMY

TIPS IN DESIGNING PRACTICAL ROUTES THAT PROMOTE FUEL ECONOMY

1. Pupils should ride the shortest distance and time possible.

2. Insofar as possible, routes should begin at the periphery of the school attendance area and follow the shortest, safest way to school.

3. Road conditions and traffic volume effects on route time and distance should be analyzed and given consideration in vehicle assignment.

4. Recognizing miles are cheaper than buses, use multiple trip routing when possible; a bus can service more than one route.

5. When possible, reduce the number of bus stops along a route. This reduces safety hazards in loading/unloading pupils; it also is a fuel economy measure.

6. Use expressways for express runs and "deadheading" only.

7. Do not schedule multiple buses over the same route; it provides pupils with an opportunity to ride any bus that comes along and can affect safety and fuel economy.

8. Eliminate door-to-door service; use zone loading servicing whenever feasible.

9. When possible, equalize routes in terms of miles; this provides a framework for even depreciation and a regular pattern of replacement.

10. Insofar as possible, eliminate natural hazards (e.g., hills) and man-made hazards (e.g., railroad crossings, dead-ends, and private roads) along each route.

11. Use feeder buses to increase safety and fuel economy.

12. Residence side load/unload on heavily traveled roads.

13. Increase pupil walking distance when safe and practical to do so.

14. Use the most efficient bus on the longest run.

15. Do not use bigger and less fuel-efficient buses than needed.

16. Refer to the "planning tips" offered at the end of Section 9.4 for further suggestions.

9.4 PLANNING TO INCREASE FUEL ECONOMY

COMPUTERIZED VERSUS MANUAL APPROACHES

Evidence is available to show that automatic approaches to routing and scheduling can reduce costs. There are also advantages to many manual systems in use, primarily for small districts. Whether routing and scheduling are performed manually or by using the assistance of a computer, one must make sure that the planning criteria and servicing factors are comprehensively investigated with regard to their impacts upon fuel use and cost.

First year savings of three school districts due to implementing computerized routing are shown below. In general, the first year of automated systems use represents a critical evaluation period for comparison. This period requires much effort and commitment by the transportation department to implement the system.

FIRST YEAR SAVINGS RECORDED BY THREE SCHOOL DISTRICTS DUE TO USE OF COMPUTERIZED ROUTING AND SCHEDULING TOOLS

SCHOOL DISTRICT	FIRST YEAR COST-SAVINGS	METHOD OF ACCOMPLISHMENT
Acalanes, Calif.		Reduced bus use, miles traveled, and saved 7,500 gallons of fuel each year.
Gross Savings:	$ 29,000	
Cost Of Service:	$ 15,800	
Net Savings:	$ 13,200	
Horsehead, New York		Reduced need for additional new buses and miles driven.
Cost Savings*:	$154,807	
New Paltz, New York		Reduced bus purchase requirements and miles driven.
Cost Savings:	$ 55,429	
Cost Reducation*:	33.9% Savings	

*Includes reductions of scheduled bus purchases due to optimal route selection.

Source: BRI Systems, Inc., based upon cost information obtained from school districts.

9.4 PLANNING TO INCREASE FUEL ECONOMY

STRATEGY FOR IMPLEMENTATION

Techniques from pin maps to automated computerized tools are used for routing. Both manual and computerized approaches require a strong commitment to make them work.

A disadvantage of manual approaches is the time requirement for an optimum route analysis. Solutions may also be based upon subjective rather than objective reasoning. On the other hand, computerized approaches require a relatively larger investment of time and dollars to design them to the needs of the district

Do not disregard the use of automated routing methods because of their complexity. Once implemented, they can provide answers to many "what if" questions faced by management operating within a limited budget. Also do not expect overnight results. Follow a strategy for design and use of these tools.

TYPICAL STRATEGY FOR IMPLEMENTING COMPUTERIZED ROUTING AND SCHEDULING TOOLS IF YOU DO IT YOURSELF

Implementation Guidelines

1. The entire system does not necessarily have to be designed at one time. Consider an approach that addresses one segment of the problem initially. Implement it, verify it, and update it in a series of planned steps.

Design Strategy

2. Allow ample time for analysis of the district requirements that must be addressed. It requires time to translate goals and objectives into a system design.
3. Don't design a "black box." Specify functional elements that will be developed, one at a time, in accordance with a management plan.
4. Although trained specialists will generally be involved in system development, invite participation from users of the data during system design planning to identify the type and format of information that will offer maximum benefits.

9.4 PLANNING TO INCREASE FUEL ECONOMY

PROBLEMS FACED IN SYSTEM IMPLEMENTATION

No routing system is without problems. The following summarizes solutions to some of the major problems faced.

MANUAL ROUTING PROBLEM SOLUTIONS

MAJOR PROBLEMS	POTENTIAL SOLUTIONS
1. Time consuming--trial and error; hesitation to go back "to the drawing board."	1. Make use of a trained analyst whose responsibilities include improved route planning.
2. Reluctance to comprehensively review new route choices.	2. Provide incentives for proven "savings."
3. Erroneous data.	3. Place emphasis on better data collection procedures.
4. Tendency to add routes and buses rather than disturb "once proven" routes.	4. Similar to solutions 1 and 2.

AUTOMATED ROUTING PROBLEM SOLUTIONS

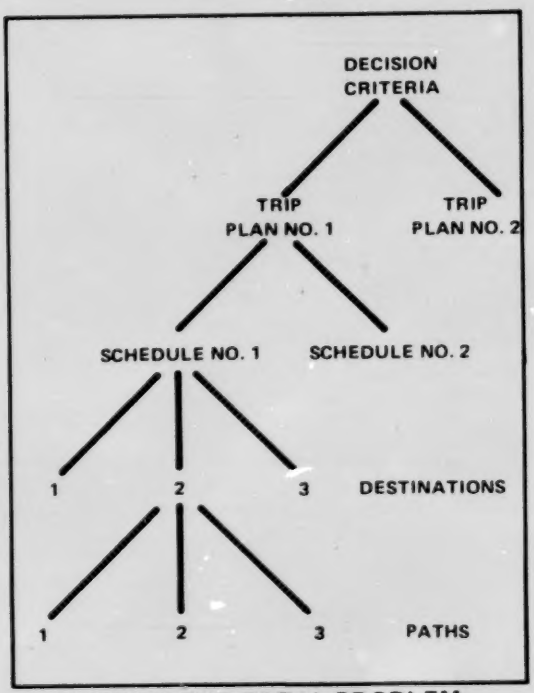
MAJOR PROBLEMS	POTENTIAL SOLUTIONS
1. Erroneous data output.	1. Data collection and input or processing tools are inadequate; improve them.
2. Lack of trained people to implement the system.	2. Hire professionals or contract for a proven service on an as-needed basis.
3. People do not know how to make it work.	3. Take advantage of industry to train them; refer to solution 2.
4. Dedication to making the program work.	4. Provide incentives for "dollar savings."
5. Program not tailored to school district.	5. General purpose concepts may not work. Take the time, effort, and dollars to modify tools to meet the district's requirements.
6. Readability of data-output.	6. Develop computer programs to translate information into a more usable format.
7. Network analysis errors.	7. Place emphasis upon better zone definitions.
8. Maps are not produced--only schedules.	8. Use computer plotting contract services; refer to solution 6.

9.4 PLANNING TO INCREASE FUEL ECONOMY

PROBLEMS FACED IN SYSTEM IMPLEMENTATION

Although many organizations offer route planning assistance, not every technique is right for every situation. Look to professionals who understand the problems of the district and are prepared to give the type of assistance that is needed. The hierarchy of routing choices shown below may appear simplified, but every experienced transportation supervisor recognizes the many factors that must be given consideration in designing the "final" route. Of importance, routes should not be "patched" so as to expose children to hazards or unreasonable conditions.

TYPICAL ROUTING DECISION STEPS



ADDRESS THE TOTAL PROBLEM.
DON'T BE AFRAID TO SEEK OUT SPECIALIZED SKILLS TO ASSIST IN PERFORMING THESE IMPORTANT FUNCTIONS.

9.4 PLANNING TO INCREASE FUEL ECONOMY

SUMMARY OF TIPS TO IMPROVE FUEL ECONOMY

There are numerous areas that can be investigated to determine if the school district can reduce its fuel consumption and operating costs. The following list of suggestions is offered to assist in defining opportunities for fuel savings. Review them and see which are applicable to your operation.

1. Coordinate school calendars insofar as possible to consolidate bus use.
2. Coordinate school start-and-dismissal times to minimize bus travel.
3. Eliminate staggered dismissal times in the same building.
4. Encourage the use of bicycles; provide adequate protection for their storage.
5. Strictly enforce walking distance statutes.
6. Increase walking distances.
7. Allow school staff members to ride buses when feasible.
8. Let older students use public mass transportation when it is available; restrict the use of the school parking lot area.
9. Centralize special education classes when practical to do so.
10. Modify attendance boundaries when such opportunities are present to minimize travel needs.

MAKE THESE TIPS A PART OF YOUR STRATEGY TO SAVE FUEL. CONSULT THE ADDITIONAL TIPS ON THE FOLLOWING PAGES TO INCREASE FUEL SAVINGS.

9.4 PLANNING TO INCREASE FUEL ECONOMY

SUMMARY OF TIPS TO IMPROVE FUEL ECONOMY: CONTINUED

11. Select the correct vehicle for the task.
12. Avoid peak traffic situations whenever possible.
13. Hold inservice programs to re-educate the staff about fuel economy practices.
14. Make sure staff members understand what constitutes "unacceptable performance."
15. Periodically review routes; update them when necessary.
16. Avoid dirt and gravel roads if other routes are available.
17. Lengthen distances between pick-up points.
18. Have older students walk to a main road for loading.
19. Use "zone loading" with stops spaced as far apart as is feasible.
20. Make sure that drivers avoid courtesy stops.
21. Enforce a maximum speed limit on routes.
22. Plan routes to make only right hand turns to reduce idling time while waiting to turn; do not increase distances traveled to accomplish this.
23. Develop an information exchange program with other districts to save fuel.
24. Use buses for deliveries when feasible to combine them with routes.
25. Train drivers when the bus is "deadheading."
26. Use satellite bus parking stations at district extremities to avoid "deadheading."
27. Use 2-way radios to re-direct buses.
28. Install trip recorders to monitor vehicle performance.
29. Promote "driving at steady speeds."
30. Purchase proper octane fuels.

9.4 PLANNING TO INCREASE FUEL ECONOMY

SUMMARY OF TIPS TO IMPROVE FUEL ECONOMY: CONTINUED

31. Audit fuel consumption. Use this information in your fuel economy management program for planning purposes.
32. Establish incentives for obtaining greater fuel economy.
33. Use the media to promote fuel conservation actions and to keep everyone aware of energy savings.
34. Publicize programs that have effectively cut down fuel consumption.
35. Develop purchasing, operation, and maintenance procedures for all equipment that uses energy.
36. Eliminate unnecessary meetings.
37. Select meeting times and locations to minimize employee travel.
38. Eliminate buses that are not needed.
39. Eliminate route overlaps.
40. Plan all stops on level ground; omit stops on inclines if possible. Use the smallest vehicle that is practical for long-distance, light-load runs.
41. Use the smallest least powerful bus that will do the job.
42. Hold workshops with drivers and mechanics to consolidate knowledge on fuel economy.
43. Sponsor and support energy conservation workshops.
44. Send mechanics to training programs and workshops to improve their skills.
45. Make sure mechanics make full use of service manuals.
46. Develop alternate routing plans for emergencies and fuel shortages.
47. Protect fuel storage from theft.
48. Use an incentive system to promote fuel economy.
49. Park buses under cover in the winter.
50. Use engine pre-heaters in cold climates.

9.4 PLANNING TO INCREASE FUEL ECONOMY

SUMMARY OF TIPS TO IMPROVE FUEL ECONOMY: CONTINUED

51. Establish district energy conservation rules and regulations.
52. Set energy saving standards as high as it is feasible to do, but realistic.
53. Develop a unit on "fuel conservation."
54. Combine athletic schedules to consolidate bus trips when possible.
55. Combine field trip requests from more than one school.
56. Share buses with other districts when holding athletic events.
57. Establish maximum distances for athletic trips.
58. Limit all special trips to full bus loads only.
59. Establish restrictions and budgets for field trips.
60. Establish a mileage allowance for each type of extra curricular activity.
61. Lock gas tanks to avoid theft.
62. Be profit motivated in your programs; remember Las Vegas casinos thrive on a five percent take.
63. Review the tips provided in the prior sections of this chapter for other fuel saving actions that can be taken.

**SEARCH FOR FUEL SAVING IDEAS.
IMPLEMENT THOSE THAT HAVE
DEMONSTRATED SUCCESS.**

9.5 MAINTAINING FOR MAXIMUM FUEL ECONOMY

MAINTENANCE AND FUEL ECONOMY

The prior chapters have shown that many practices can increase the fuel economy of the fleet, but only a good maintenance program can insure that this economy is maintained. Simple tune-ups can improve fuel economy from 6-10 percent. The same tune-up on a vehicle whose engine is in poor mechanical condition can increase fuel economy anywhere from 20 to 100 percent.

Three areas are important in maintaining for increased fuel economy: implementing a practical, effective preventive maintenance program, using modern equipment to service the fleet, and installing a record-keeping system that provides management a continuous measure of fleet performance.

PREVENTIVE MAINTENANCE IS THE KEY TO INCREASED FUEL ECONOMY

Preventive maintenance is investing man-hours and dollars in a scheduled program to insure that maximum efficiency and fullest life-expectancy is obtained from each vehicle in the fleet. It consists of a planned program designed to reduce emergency breakdowns through a rigid scheduling of vehicles for servicing at specific intervals. A good maintenance program has elements which include but are not limited to:

1. A monitoring, recording, and tracking information system that shows fuel economy and repair history of each vehicle in the fleet.
2. Procedures for responsively reporting problems and maintenance follow-up.
3. Contracting of specialized maintenance services when necessary to increase fleet reliability.
4. Using analyzers and modern tools to service the fleet.
5. Continuing in-service training programs and workshops to increase staff skills.
6. Management information systems designed to provide feedback.

9.5 MAINTAINING FOR MAXIMUM FUEL ECONOMY

USE MODERN EQUIPMENT TO SERVICE THE FLEET

The use of equipment that allows the maintenance staff to keep engines tuned for maximum fuel economy offers numerous dividends. Do not sacrifice performance. When in doubt about the value of equipment, consult peers and professionals for their opinion. When making major equipment purchases, perform a benefit-cost analysis. Make sure that consideration is given to reduced downtime savings in calculating the benefits.

USE RECORD-KEEPING SYSTEMS THAT SHOW FLEET PERFORMANCE

Good maintenance programs provide an environment for increased safety. Go one step further and place emphasis upon increasing the fuel economy of the fleet in the program. Develop a maintenance record system that will provide management with the information that is necessary for control. Such a system should provide at minimum the following important information:

1. Vehicle purchase date and cost.
2. Vehicle mileage, fuel, and oil consumption history.
3. Manufacturer's recommended maintenance and servicing schedules.
4. History of maintenance performed on each vehicle.
5. Costs of maintenance performed: labor, materials, contracting services, etc.
6. Record of vehicle equipment purchases and their performance (e.g., tires).
7. Other information of importance in servicing the fleet.

Such information is invaluable in monitoring and evaluating bus performance.

9.5 MAINTAINING FOR MAXIMUM FUEL ECONOMY

EQUIPMENT AND TECHNIQUES CAN BE USED TO OBTAIN FUEL ECONOMY; BUT ONLY PEOPLE CAN DO IT

Fuel economy depends on equipment, programs, and people. It depends most on people.

Let the staff know that the district wants to improve fuel economy. Provide an environment to achieve this. Develop procedures for saving fuel. Put them in writing. Solicit fuel saving suggestions, acknowledge them, recognize and publicize good performance, instill a positive attitude to improve performance, and get everyone involved. Use performance information as a yardstick for taking actions.

Establish in-service maintenance training programs to increase personnel skills. The staff should make good use of manufacturer maintenance manuals. Hold workshops with other districts to discuss solutions to maintenance problems. These workshops offer maintenance personnel an opportunity to exchange ideas and become familiar with new equipment; they can increase operation effectiveness. Send personnel to the programs and workshops that are offered by equipment manufacturers. Instill attitudes of "self-improvement," "performance," and "teamwork." Involve the driving staff in these programs. Their efforts are important in signaling potential vehicle problems to the maintenance department. Each school bus driver should have a basic knowledge about the equipment and the simple actions that can be taken to increase fuel economy. Checking tire inflation pressure is one such simple but important action. Environmental Protection Agency studies have shown that underinflated tires can reduce fuel economy anywhere from 3 to 7 percent. Teamwork is important for obtaining fuel economy. Promote it.

9.5 MAINTAINING FOR MAXIMUM FUEL ECONOMY

SEARCH FOR IDEAS THAT SAVE FUEL

Although it is recognized that many times it takes money to save money, remember that even simple and inexpensive actions can result in fuel savings. The following is a list of simple actions that saved school districts fuel and dollars(18). Many more types of actions can be identified in the school transportation community. Discuss the opportunities for saving fuel with your peers. You may find just the combination that you are looking for to obtain greater fuel savings.

1. A school bus operation in Southern California was able to extend servicing periods for maintaining the diesel fleet by 30 percent based on the findings of an oil analysis taken every 3 months.
2. A district in Ohio reduced the combined cost of maintenance and fuel by 46 percent by switching from standard transmission-gasoline buses to similar sized diesels with automatic transmissions. Performance cost data provided the framework for implementing the move.
3. Performance tracking allowed an operation in California to increase fuel economy and extend the wear of its tires by nearly 50 percent by switching to steel-belted radials; in specific instances, it obtained a 300 percent increase in tire wear from the use of radials.

**DISCUSS FUEL SAVING ACTIONS WITH YOUR PEERS.
YOU MAY FIND JUST THE COMBINATION
THAT YOU ARE LOOKING FOR -- A COMBINATION
THAT WILL SAVE FUEL AND DOLLARS.**

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(18) Cases presented are based upon interviews and survey data obtained by BRI Systems.

9.5 MAINTAINING FOR MAXIMUM FUEL ECONOMY

TAKE ADVANTAGE OF SPECIALIZED SERVICES TO INCREASE FUEL ECONOMY WHEN YOU CAN'T DO IT ALONE

Take advantage of available contractor maintenance in highly specialized areas when the staff does not have the skills or equipment to do it alone. Oil analysis is an example of the services that are offered. Metal content in engine oil is an indicator of need for engine overhaul. After the engine break-in period, wear metal content indicates that the engine is not performing at high efficiency. Such analysis, costing anywhere from $10-$15 per sample, will indicate when oil should be changed, possibly extending drain intervals, and allow the fleet to be operated at peak efficiency.

WHAT ENGINE OIL TELLS YOU ABOUT SCHOOL BUS PERFORMANCE

- The presence of resins indicate oil oxidation.
- Viscosity changes show the presence of oil contamination, oil oxidation, and fuel dilution.
- Metal content indicates a serious condition that may result in engine failure as shown:

METAL TYPE	POSSIBLE SOURCE OF WEAR
Aluminum	Piston or bearings
Chromium	Piston rings or cylinder lining
Copper	Bearings, bushings, filter screen
Iron	Roller bearing, piston ring, valve train, crankshaft, camshaft, gears, cylinders
Lead	Bearings
Nickel	Bearings, valves, piston rings
Silicon	Air-borne dirt
Silver	Bearings
Sodium	Air-borne dirt, water contamination
Tin	Bearings, bushings

Source: Quaker State Oil Refining Company, Oil City, Pennsylvania.

9.5 MAINTAINING FOR MAXIMUM FUEL ECONOMY

MANAGEMENT GUIDELINES

Use maintenance management tools to help evaluate problems and insure that they are solved in a timely manner. Management-by-Exception provides a framework for acting when something goes wrong and needs to be corrected. The system begins with bus driver daily records being forwarded to the maintenance supervisor. When the driver report indicates a potential problem, act on it.

If computerized services are available to the operation, they can provide a basis for work order reporting, tracking, maintenance scheduling, and performance recording. Many data management and reporting systems are available. Check with your peers or request information from the many professional organizations that supply these services.

A manual reporting system can also be effective, primarily for smaller fleets. Make sure that a log is kept on each vehicle; maintenance and fuel economy information should be recorded, analyzed, and acted upon. Use performance data as a basis for decision-making. Such information can show which vehicles are offering the district the best performance for each dollar invested.

The following pages offer an example of a typical driver daily report and mechanical work order report. Many reporting formats are available; use the one which best meets the needs of the operation. In most states, the Director of Pupil Transportation is familiar with the forms and systems used by school districts in the state as well as others throughout the nation. Consult this individual and other professionals for assistance in updating your system.

9.5 MAINTAINING FOR MAXIMUM FUEL ECONOMY

MAINTENANCE DATA RECORDING

The sample forms illustrate one method for recording and keeping track of fuel and oil use on a daily basis. Such a form also provides a mechanism for maintenance requests, follow-up, and recording of pertinent vehicle repair and parts replacement data. Select a system which fits the district's pattern of operation and will allow for vehicle data to be recorded for future analysis.

TYPICAL DRIVER DAILY REPORT

DRIVER FUEL AND OIL RECORD | DATE

VEHICLE NO. | ODOMETER | SIGNATURE

SIDE 1 OF DAILY RECORD CARD

(TURN OVER)

GAS		DIESEL		OIL	
GALS	TENTHS	GALS	TENTHS	QUARTS	☐PUPIL TRANS. ☐DRIVER TRAINING ☐MAINTENANCE ☐POOL/STAFF
				Maintenance Dept. Action	☐ (OTHER) _____

SIDE 2 OF DAILY RECORD CARD

DRIVER DAILY CHECKLIST

☐ Fuel	☐ Glass & Mirrors
☐ Oil	☐ Door Releases
☐ Tire Pressure	☐ Windows
☐ Gauges And Horn	☐ Seat Belts
☐ Lighting	☐ Heating System
☐ Windshield Wipers	☐ Clutch Pedal
☐ _____	☐ Air Pressure Device

REPAIRS RECOMMENDED BY DRIVER _____

Dept. Action

TYPICAL MECHANICAL REPAIR WORK ORDER

CONSULT WITH THE DIRECTOR OF PUPIL TRANSPORTATION IN YOUR STATE AND REVIEW THE MANY FORMS IN USE.

FAILURE CODE: EL

YOUR SCHOOL _____ REQ. _____ APPROVED _____ DATE

REPAIR TYPE: I

A: Accident
I: Interim Repair
P: Preventive Maintenance
R: Road Failure
S: Schedule Repair
O: Other

VEHICLE NO.	DATE OF ORDER
16	7-8-77
LICENSE NO.	SPEEDOMETER
ED 2154	12,510
YEAR	ENGINE
1975	F-D
CAPACITY (SIZE)	CHASIS CODE:
72	CR

FOR OFFICE USE ONLY

	WORK CENTER CODE		
Sublet Labor			
Total Labor	G	2	20
Total Parts			15
Grease & Oil			
Tax			01
TOTALS		2	36

QTY.	PART NO.	DESCRIPTION	COST
1	LF-15	Bulb	15
	PARTS TOTAL		15
	Grease		
	Trans. Oil		
	Motor Oil		
	Sublet Labor		

LABOR COSTS

TYPE OF WORK DONE CODE	JOB DESCRIPTION	HRS.	MIN.
IR	Inspect and Replace L/F Bulb		20
	TOTAL LABOR		20

CHECK LIST

Lubrication	
Oil	✓
Oil Filter	
Air Filter	✓
Wash	
Motor Tune	
Brakes	✓
Adjust Hand Brakes	✓
Check Tires	✓
Headlights	✓
Other Lights	✓
Radiator	✓
Battery	✓
Adjust Clutch	
Transmission	
Differential	
Master Cylinder	

White Copy - Transportation Office
Canary Copy - Bookkeeping
Buff Ledger - Garage

(119)

SOURCE: Courtesy of Paradise Valley School District, Arizona; Modified Form.

9.5 MAINTAINING FOR MAXIMUM FUEL ECONOMY

SUMMARY OF MAINTENANCE TIPS TO IMPROVE FUEL ECONOMY

1. Set goals to operate at peak efficiency, establish programs to reach these goals.
2. Promote inhouse training programs to increase staff effectiveness.
3. Manage by exception; if a bus is not obtaining desired fuel economy, find out why.
4. Use reporting systems that offer follow-up and feedback.
5. Take advantage of modern equipment and techniques to increase fleet reliability.
6. Use engine analyzing equipment.
7. Maintain tires at maximum recommended pressure; check regularly for wear and damage.
8. Change oil, PCV, air and gas filters regularly.
9. Use tire tread wear patterns and depth as a guide to alignment needs.
10. Look inside the exhaust pipe for black soot; it is an indicator of engine inefficiency.
11. Once a year perform a major inspection; cylinder compression, valve clearance, fuel pump, vacuum pressure, etc.
12. Reduce engine idle speed.
13. Periodically check the vehicle to insure it is running efficiently; check the carburetor for cleanliness, idle speed, air-fuel mixture, float level, accelerator pump stroke, automatic choke, and air or gasoline leaks; also check the coil, condensor, rotor, distributor cap, spark plugs, spark plug gap, firing voltage, ignition points gap, dwell and resistance, and timing.
14. Check oil, antifreeze, windshield washer fluid, battery, and tire pressure during fill-ups.
15. Use an oil suitable for the driving environment.
16. Follow manufacturer's recommendations in maintaining the vehicle.
17. Promote an environment of "performance" and "teamwork."
18. Resolve maintenance problems immediately.

PART VI

CONCLUSION

"WHEN MAN POINTS A FINGER AT SOMEONE, HE SHOULD REMEMBER THAT FOUR OF HIS FINGERS ARE POINTED AT HIMSELF"

LOUIS NIZER

10.1 NECESSARY ACTIONS

DEVELOP A STRATEGY TO INCREASE FUEL ECONOMY

Anyone reading this handbook should be convinced that fuel management problems can be resolved to face the uncertain future. The solution requires a basic reexamination of habits, practices, and policies that have been used over long periods of time.

The success of fuel economy management depends to a great extent on the preparation made and the overall ability to communicate the need for saving energy. It is also dependent upon applying some basic skills to achieve energy management objectives.

The ability to recognize, analyze, and respond to energy problems is important. This ability is enhanced by:

1. Taking the time and effort to evaluate current practices; review fuel saving objectives.
2. Researching ideas that can help the district save fuel.
3. Training and motivating personnel to save fuel.
4. Stimulating actions that can increase pupil transportation effectiveness in the school district.

Take advantage of the best energy resource that is available in the school district--the energy of people-individual self-esteem--to save fuel. The future depends to a large degree on the extent to which this resource is used.

The use of common sense along with a personal commitment to save fuel in the school district are important elements in making school transportation "a winner." If the district takes the time required to plan for better fuel economy and develops a personal strategy to increase pupil-miles-per-gallon, the meaningful savings discussed in this handbook can be obtained.

10.1 NECESSARY ACTIONS

WHAT CAN BE DONE TO SAVE ENERGY

Fuel economy management represents a foundation for saving energy in our schools and in our personal activities. It is achieved through practical, common sense techniques to save dollars and by focusing attention upon increasing productivity and performance.

The Board of Education in every state can encourage school districts to move in the direction of greater fuel economy. The State Board of Education can update its reimbursement formulas to encourage the purchase of equipment that offers more miles-per-gallon. This has proved successful in States such as Ohio, it can be done on a nationwide basis.

Every school board can place emphasis upon fuel economy management in its community. Such actions will save the community dollars. They are in line with our national energy conservation goals.

Every school district has an opportunity to begin fuel economy management as a part of its regular management practices. Implement programs to purchase, plan, drive, route, schedule, and maintain for greater fuel economy. More pupil-miles-per-gallon is achievable through fuel economy management.

TAKE ACTIONS TODAY TO BEGIN YOUR FUEL ECONOMY MANAGEMENT PROGRAM.

MAKE FUEL ECONOMY MANAGEMENT A PART OF YOUR MANAGEMENT PROGRAM.

10.2 ADDITIONAL TIPS FOR SAVING ENERGY

Tips for saving energy in other areas of school operation are listed. Take advantage of actions that can reduce the school's utility bills.

1. Establish a committee to review energy use.
2. Survey energy use periodically.
3. Record energy consumption in all facilities; use this information as a mechanism for identifying energy conservation actions.
4. Check the school's heating and cooling systems to make sure they are up to standard.
5. When heating buildings, reduce the temperature to be maintained when the facilities are not in use.
6. Eliminate heating and cooling buildings on holidays and weekends.
7. Instruct cleaning personnel to turn off lights and to inspect heating and cooling thermostat settings in each classroom and work area.
8. Change filters regularly; follow the manufacturer's maintenance instructions for all equipment.
9. Inspect and calibrate equipment controls periodically.
10. Insulate air ducts and hot water pipes.
11. Close off all unnecessary openings.
12. Install double glass panes on windows.
13. Add insulation to walls and ceilings to reduce heat transfer.
14. Check utility bills to make sure that no irregularities exist.
15. Investigate the opportunities for saving energy in food services, using pressure cookers, microwave ovens, smaller and more energy efficient appliances, keeping freezers as full as possible, centralizing food preparation, and designing nutritional menus that require less baking and cooking time.

10.2 ADDITIONAL TIPS FOR SAVING ENERGY

Additional tips for saving energy in other areas of school operation:

16. Avoid arbitrary thermostat settings. Establish rules for temperature control; consider centralized control.

17. Design facilities to use mirrors whenever practical to reflect light; also paint walls with light colors.

18. Reduce heat to a minimum in locker rooms and the auditorium.

19. Schedule all evening meetings in a central area.

20. Perform janitorial services early so that electricity may be turned off earlier.

21. Caulk and weatherstrip windows, sash, doors, and roof flashing.

22. Turn off all lighting after school has been dismissed.

23. Encourage teachers to turn off lights in empty rooms.

24. Reduce lighting levels when safe to do so; reduce exterior lighting levels.

25. Install photo cells to control exterior lights.

26. Use fluorescent fixtures whenever possible. They last longer and use less energy.

27. Clean fluorescent tubes regularly; dirty tubes reduce efficiency.

28. Replace broken windows.

29. Keep register and radiator surfaces clear of obstructions.

30. Reduce shower water temperatures.

31. Change shower heads to reduce water volume.

10.2 ADDITIONAL TIPS FOR SAVING ENERGY

A CHECKLIST OF ADDITIONAL ENERGY SAVING TIPS FOR SCHOOL BUILDINGS

- ☐ Use timeclocks on heating systems for control.
- ☐ Insulate piping and ductwork.
- ☐ Keep ventilation air requirements to a minimum.
- ☐ Use enthalpy controls on cooling systems.
- ☐ Use zone thermostats, one in each area.
- ☐ Use heat reclaim devices when feasible.
- ☐ Install photo cells on outside lighting.
- ☐ Provide lighting switches in every classroom.
- ☐ Keep detailed reports on power consumption.

10.2 ADDITIONAL TIPS FOR SAVING ENERGY

TIPS FOR STUDENTS AND STAFF TO SAVE FUEL

Use the following practices in your daily activities to save fuel. They are based upon the proven principles of fuel economy management.

1. Carpool to school and work as often as possible.
2. Carpool for family business and recreation.
3. Use public transportation whenever it is available.
4. Commute via public transportation. Use the extra car, bicycle, walk, kiss-and-ride, or carpool to get to a main transit route.
5. Initiate a vanpool commuting service in the community.
6. Make careful and complete shopping lists; combine shopping and personal trips, plan the most advantageous route, and drive less.
7. Telephone instead of visiting; at a minimum telephone ahead.
8. Schedule meetings at locations that minimize travel.
9. Double-up necessary meetings.
10. Purchase a lighter, less powerful car.
11. Keep your car "tuned up" to obtain maximum performance from it.
12. Study your travel habits; search out opportunities for saving fuel.
13. Vacation near home and in areas where local transportation is available.
14. Vacation with friends.
15. Eliminate unplanned pleasure rides; substitute walks and bicycle trips.
16. Find out why certain drivers get good fuel economy performance; use driving techniques that can improve your miles-per-gallon.

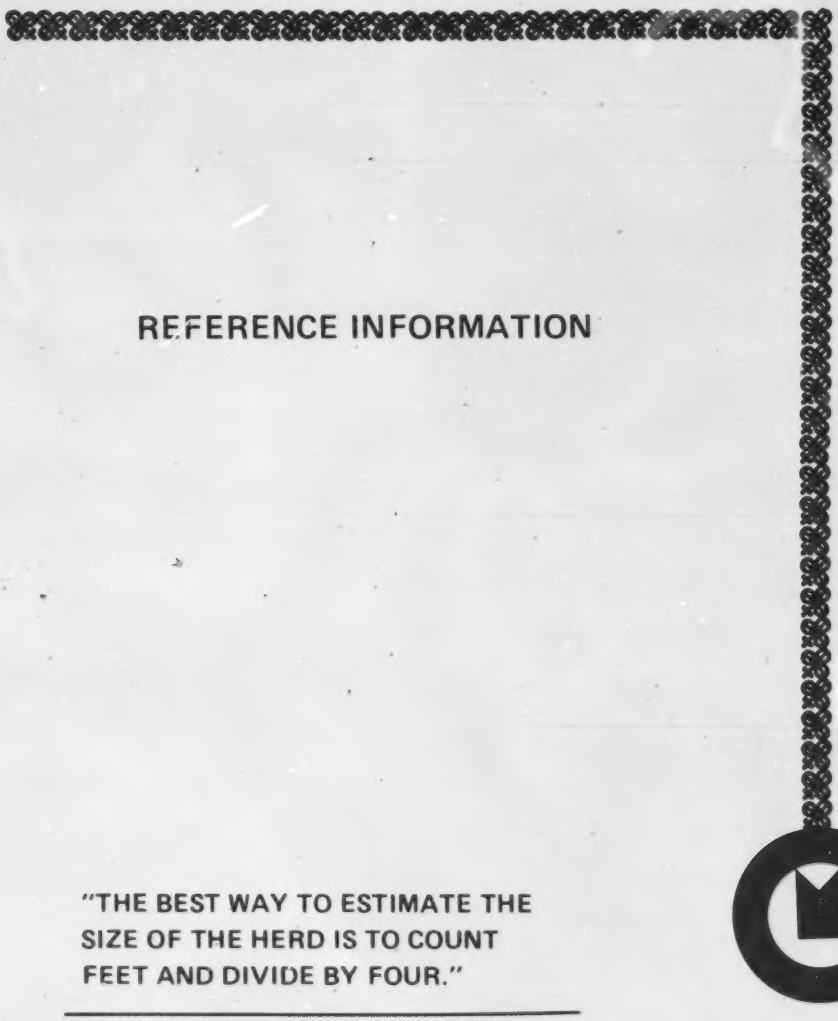
10.2 ADDITIONAL TIPS FOR SAVING ENERGY

A CHECKLIST OF FUEL SAVING TIPS
FOR THE STAFF AND STUDENTS

- ☐ When you must drive, carpool as often as possible.
- ☐ Measure distance in gallons, not miles.
- ☐ Plan your driving routes to avoid bottlenecks.
- ☐ Eliminate those costly unplanned drives.
- ☐ Drive slower, drive for fuel economy.
- ☐ Purchase the lightest car that fulfills your needs.
- ☐ Select only those accessories necessary for comfort.
- ☐ Consider fuel saving equipment in your purchases.
- ☐ Maintain your car on a periodic basis.
- ☐ Make sure that your car's tires are properly inflated.

PART VII

REFERENCE INFORMATION



"THE BEST WAY TO ESTIMATE THE SIZE OF THE HERD IS TO COUNT FEET AND DIVIDE BY FOUR."

OLD COWBOY TALE, FROM
HOW TO MAKE ADVERTISING WORK,
McGRAW-HILL BOOK CO., 1967.

11.1 STATE DIRECTORS OF PUPIL TRANSPORTATION

ALABAMA

Coordinator, Pupil Transportation
State Office Building
Montgomery 36104
(205) 832-5122

ALASKA

Deputy Director, Field Services
Pouch F, State Office Building
Juneau 99801
(907) 465-2850

ARIZONA

Manager, Pupil Transportation
Office of Highway Safety
206 South 17th Avenue
Phoenix 85007
(602) 261-7341

ARKANSAS

Supervisor, School Transportation
Department of Education
Little Rock 72201
(501) 371-1560

CALIFORNIA

Field Representative, Bureau of Administrative Services
Department of Education
Sacramento 95814
(916) 322-2470

COLORADO

Supervisor, Supporting Services
Department of Education
201 East Colfax
Denver 80202
(303) 892-2291

CONNECTICUT

State Department of Education
State Office Building
165 Capitol Avenue
Hartford 06115
(203) 566-4023

DELAWARE

Supervisor, Transportation
Department of Public Instruction
Townsend Building
Dover 19901
(302) 678-4696

FLORIDA

Administrator, Transportation
Department of Education
Knott Building
Tallahassee 32304
(904) 488-4405

GEORGIA

Administrator, Transportation
Department of Education
156 Trinity Avenue
Atlanta 30303
(404) 656-2467

HAWAII

Administrator, Transportation
Department of Education
1037 South Bretania Street
Honolulu 96814
(808) 548-2364

IDAHO

Supervisor, Transportation
Department of Education
Boise 83720
(208) 384-3106

11.1 STATE DIRECTORS OF PUPIL TRANSPORTATION

ILLINOIS

Pupil Transportation Services
Office of Education
100 North First Street
Springfield 62777
(217) 525-7484

INDIANA

Director, School Traffic Safety
Department of Public Instruction
120 West Market Street
Indianapolis 46204
(317) 633-4694

IOWA

Division of Transportation
Department of Public Instruction
Des Moines 50319
(515) 281-5811

KANSAS

Director of Safety
Safety Department
State Office Building
Topeka 66612
(913) 296-3551

KENTUCKY

Pupil Transportation Division
Department of Education
Capital Plaza Tower
Frankfort 40601
(502) 564-4718

LOUISIANA

Supervisor, Transportation
P.O. Box 44064
Baton Rouge 70804
(504) 389-2211

MAINE

Transportation Director
Driver Education & Safety
Education Building
Augusta 04333
(207) 289-2371

MARYLAND

Safety & Transportation
Department of Education
P.O. Box 8717
Baltimore 21240
(301) 796-8300

MASSACHUSETTS

Bureau of School Management Services
Department of Education
182 Tremont Street
Boston 02111
(617) 727-5790

MICHIGAN

Department of Education
Box 420
Lansing 48902
(517) 373-3314

MINNESOTA

Director, Pupil Transportation
Capitol Square Building
550 Cedar Street
St. Paul 55101
(612) 296-2839

MISSISSIPPI

Department of Education
P.O. Box 771
Jackson 39205
(601) 354-6921

11.1 STATE DIRECTORS OF PUPIL TRANSPORTATION

MISSOURI

Director, Pupil Transportation
Department of Elementary and
Secondary Education
P.O. Box 480
Jefferson City 65101
(314) 751-2626

MONTANA

Supervisor, Transportation
Department of Public
Instruction
Helena 59601
(406) 449-3167

NEBRASKA

Transportation Specialist
Department of Education
233 South 10th Street
Lincoln 68508
(402) 471-2452

NEVADA

Office of Technical Assistance
Department of Education
400 West King
Carson City 89701
(702) 805-5700

NEW HAMPSHIRE

Department of Education
410 State House Annex
Concord 03301
(603) 271-2105

NEW JERSEY

Director, Pupil Transportation
Department of Education
225 West State Street
Trenton 08625
(609) 292-8534

NEW MEXICO

Director, Transportation
Department of Education
Education Building
Santa Fe 87503
(505) 827-2108

NEW YORK

Supervisor, School Business
Department of Education
Albany 12230
(518) 474-3384

NORTH CAROLINA

Director, Transportation
Board of Education
Education Building
Raleigh 27611
(919) 829-3071

NORTH DAKOTA

Director, School Transportation
Department of Public
Instruction
Capitol Building
Bismarck 58505
(701) 224-2270

OHIO

Pupil Transportation
Department of Education
811 State Office Building
Columbus 43215
(614) 466-4230

OKLAHOMA

Transportation Section
Finance Division
2500 North Lincoln
Oklahoma City 73105
(405) 521-3472

11.1 STATE DIRECTORS OF PUPIL TRANSPORTATION

OREGON

Pupil Transportation Services
Department of Education
Salem 97310
(503) 378-3578

TEXAS

School Transportation
Texas Education Agency
11th & Brazos Street
Austin 78701
(512) 475-2631

PENNSYLVANIA

Pupil Transportation Division
Department of Transportation
Harrisburg 17123
(717) 787-6453

UTAH

Specialist, Transportation
Department of Education
248 East 500 South
Salt Lake City 84111
(801) 533-5436

RHODE ISLAND

Driver & Safety Education
Providence 02908

VERMONT

Education Field Services
Department of Education
129 State Street
Montpelier 05602
(802) 828-3145

SOUTH CAROLINA

Director, Transportation
512 Rutledge Building
Columbia 29201
(803) 758-2762

VIRGINIA

Supervisor, Pupil
Transportation
Board of Education
Richmond 23216
(804) 770-2619

SOUTH DAKOTA

Director, Pupil Transportation
Kneip Building
Pierre 57501
(605) 224-3247

WASHINGTON

Supervisor, Pupil
Transportation
Superintendent of Public
Instruction
Olympia 98504
(206) 753-6736

TENNESSEE

Pupil Transportation
Department of Education
Cordell Hull Building
Nashville 37219
(615) 741-2927

WASHINGTON, D.C.

Transportation Officer
D.C. Public Schools
2115 5th Street, N.E.
Washington, D.C. 20002
(202) 576-6302

11.1 STATE DIRECTORS OF PUPIL TRANSPORTATION

WEST VIRGINIA

Director, School
Transportation
Department of Education
1900 Washington Street
Charleston 25305
(304) 348-2711

WISCONSIN

Administrator, Pupil
Transportation
Department of Pupil
Instruction
126 Langdon Street
Madison 53702
(608) 266-2853

WYOMING

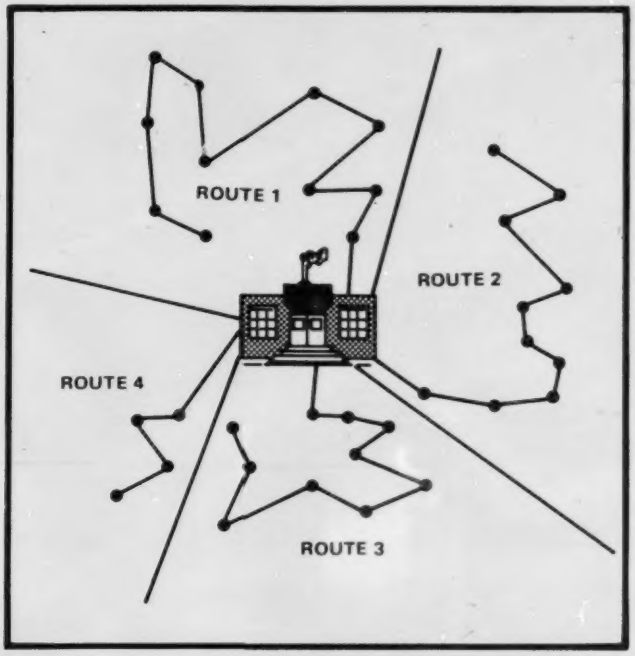
Coordinator, Pupil
Transportation
State Office Building West
Department of Education
Cheyenne 82002
(307) 777-7293

CONSULT THE DIRECTOR IN YOUR STATE TO OBTAIN INFORMATION ABOUT:

- FUEL CONSERVATION PROGRAMS
- ENERGY WORKSHOPS
- RECORD MANAGEMENT SYSTEMS
- ROUTING AND SCHEDULING PROGRAMS
- ENERGY SAVING EQUIPMENT

THAT HAVE HELPED SCHOOL DISTRICTS SAVE FUEL AND DOLLARS

USE AVAILABLE RESOURCES TO SAVE ENERGY



11.2 SOCIETIES, ASSOCIATIONS, AND INSTITUTES OFFERING ENERGY CONSERVATION INFORMATION

1. Air-Conditioning and Refrigeration Institute, 1815 N. Ft. Myer Dr., Arlington, Virginia 22209.
2. American Boiler Manufacturers Association, 1500 Wilson Blvd., Suite 317, Arlington, Virginia 22209.
3. American Consulting Engineers Council, 1155 15th Street, N.W., Rm. 713, Washington, D.C. 20005.
4. American Gas Association, 1515 Wilson Blvd., Arlington, Virginia 22209.
5. American Industrial Hygiene Association, 210 Haddon Ave., Westmont, New Jersey 08108.
6. American Institute of Architects, 1735 New York Ave., N.W., Washington, D.C. 20006.
7. American Institute of Plan Engineers, 1021 Delta Ave., Cincinnati, Ohio 45208.
8. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.
9. American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., 345 E. 47th St., New York, New York 10017.
10. American Society of Mechanical Engineers, 345 E. 47th St., New York, New York 10017.
11. American Society for Testing and Materials, 1916 Race St., Philadelphia, Pennsylvania 19103.
12. Associated General Contractors of America, 1957 E. St., N.W., Washington, D.C. 20006.
13. Better Heating-Cooling Council, 35 Russo Pl., Berkeley Heights, New Jersey 07922.
14. Building Research Advisory Board, National Research Council, National Academy of Sciences-National Academy of Engineering, 2101 Constitution Ave., N.W., Washington, D.C. 20418.
15. Construction Specifications Institute, 1150 Seventeenth St., N.W., Suite 300, Washington, D.C. 20036.
16. Edison Electric Institute, 90 Park Ave., New York, New York 10016.
17. Gas Appliance Manufacturers Association Inc., 1901 N. Ft. Myer Dr., Arlington, Virginia 22209.
18. Heat Exchange Institute, 122 E. 42nd St., New York, New York 10017.

11.2 SOCIETIES, ASSOCIATIONS, AND INSTITUTES OFFERING ENERGY CONSERVATION INFORMATION

19. Illuminating Engineering Society, 345 E. 47th St., New York, New York 10017.
20. Institute of Electrical & Electronics Engineers, Inc., 345 E. 47th St., New York, New York 10017.
21. Instrument Society of America, Stanwix St., Pittsburgh, Pennsylvania 15222.
22. Mechanical Contractors Association of America, Inc., 5530 Wisconsin Ave., Suite 750, Washington, D.C. 20015.
23. National Association for Pupil Transportation, Executive Secretary, P.O. Box 1475, Fort Worth, Texas 76101.
24. National Association of Oil Heating, Service Manager, Inc., 60 E. 42nd St., New York, New York 10017.
25. National Association of Power Engineers, Inc., 176 W. Adams St., Suite 1411, Chicago, Illinois 60603.
26. National Coal Association, Coal Bldg., 1130 17th St., N.W., Washington, D.C. 20036.
27. National Electrical Contractors Association, 7315 Wisconsin Ave., Washington, D.C. 20014.
28. National Electrical Manufacturers Association, 155 E. 44th St., New York, New York 10017.
29. National Insulation Contractors Association, 8630 Fenton St., Suite 506, Silver Spring, Maryland 20910.
30. National LP-Gas Association, 79 W. Monroe St., Chicago, Illinois 60603.
31. National Oil Fuel Institute, Inc., 60 E. 42nd St., New York, New York 10017.
32. National School Transportation Association, Executive Director, 4616 Lawn Court, Fairfax, Virginia 22030.
33. National Society of Professional Engineers, 2020 K. St., N.W., Washington, D.C. 20006.
34. Refrigeration Service Engineers Society, 2720 Des Plaines Ave., Des Plaines, Illinois 60018.
35. Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa., 15096.
36. Society of American Value Engineers (SAVE), 2550 Hargrave Dr., Smyrna, Georgia 30080.
37. Standards Engineers Society, P.O. Box 7507, Philadelphia, Pennsylvania 19101.

11.2 SOCIETIES, ASSOCIATIONS, AND INSTITUTES OFFERING ENERGY CONSERVATION INFORMATION

38. Steam Heating Equipment Manufacturers Assoc., c/o Samuel J. Reid, Barnes & Jones, Inc., P.O. Box 207, Newtonville, Maryland 02160.
39. Thermal Insulation Manufacturers Association, Inc., 7 Kirby Plaza, Mt. Kisco, New York 10549.
40. Underwriters' Laboratories, Inc., 333 Pfingsten Rd., Northbrook, Illinois 60062.

CONTACT PROFESSIONAL ORGANIZATIONS AND TRADE ASSOCIATIONS FOR INFORMATION ABOUT ENERGY SAVING EQUIPMENT

UNDERSTAND WHAT CONTRIBUTES TO FUEL ECONOMY

A LIST OF LOCAL SOURCES OF INFORMATION IS PROVIDED BELOW FOR REFERENCE. CONTACT THESE SOURCES FOR INFORMATION. ALSO CONSULT WITH YOUR PEERS.

11.3 LOCAL INFORMATION SOURCES

1. Chapters of above mentioned societies, associations, and institutions.
2. Commercial fleets.
3. Chamber of Commerce.
4. Department of Education.
5. Public and educational institution libraries.
6. State Energy Office.
7. Contractors, manufacturers, suppliers, professional consultants, and others whom you work with on a regular basis.

TAKE ADVANTAGE OF THE INFORMATION SOURCES IN YOUR COMMUNITY

U. S. GOVERNMENT SOURCES OF INFORMATION

11.4 U. S. GOVERNMENT SOURCES

WRITE THE PUBLIC INFORMATION OFFICE
OF THE FOLLOWING U. S. GOVERNMENT
ORGANIZATIONS FOR INFORMATION
ABOUT ENERGY CONSERVATION:

1. Department of Commerce, Office of Energy Programs, 14th & Constitution Ave., Washington, D.C. 20230.
2. Energy Research & Development Administration, 400 First Street, N.W., Washington, D.C. 20545.
3. Federal Energy Administration, Office of Energy Conservation and Environment, 12th & Pennsylvania, N.W., Washington, D.C. 20461.
4. Department of Transportation, 400 Seventh Street, S.W., Washington, D.C. 20590.
5. National Bureau of Standards, Office of Energy Conservation, Building 226, Rm. B114, Washington, D.C. 20234.
6. National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161.
7. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

NOTE: THE ORGANIZATIONS SPECIFIED IN REFERENCES NO. 2 AND NO. 3 ABOVE ARE NOW A PART OF THE U.S. DEPARTMENT OF ENERGY.

YOU MAY ALSO WRITE TO:

SUPERINTENDENT OF DOCUMENTS
U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON, D.C. 20402

NATIONAL TECHNICAL INFORMATION SERVICE
5285 PORT POYAL ROAD
SPRINGFIELD, VA. 22161

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